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City planning Arroyo Grande
City planning Noise abatement

GENERAL PLAN ELEMENT

1976

NOISE

ACKNOWLEDGEMENTS

This Noise Element was prepared forthe San Luis Obispo County and Cities Area Coordinating Council. The staff of Envicom Corporation wish to acknowledge the cooperating and invaluable assistance extended to them during this study by the administrative staff of the County and City governments, especially:

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THE CITY OF

GENERAL PLAN ELEMENT

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1976

POLICY REPORT

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RESOLUTION NO. 76-467 G

RESOLUTION OF THE PLANNING COMMISSION OF THE CITY OF ARROYO GRANDE ADOPTING THE NOISE ELEMENT OF THE GENERAL PLAN.

WHEREAS, the Planning Commission of the City of Arroyo Grande has prepared a general plan report, together with general plan maps, entitled the "Noise" plan, required by Government Code Section 65302 (g), and did all things legally and technically required by law to develop reports and maps adequate in scope and authority to serve the purpose of a general plan; and

WHEREAS, pursuant to Government Code Section 65501 et seq. the City Planning Commission gave required notice and did hold a public hearing on September 21, 1976, for the purpose of considering the adoption of the Noise Element of the General Plan report and maps, and at which public hearing the Noise Plan, reports and maps were displayed, explained and reported upon; and

WHEREAS, said Noise Element of the General Plan report and maps thereof are necessary for sound future community development, the preservation of community values, and the promotion of the general health, safety, convenience and welfare of the citizens of the City of Arroyo Grande; and

WHEREAS, the Planning Commission of the City of Arroyo Grande has a responsibility to plan for the desirable future growth and development of the City of Arroyo Grande;

NOW, THEREFORE, THE PLANNING COMMISSION OF THE CITY OF ARROYO GRANDE DOES HEREBY RESOLVE AS FOLLOWS:

Section 1. The Planning Commission of the City of Arroyo Grande does hereby find and determine that the public interest, convenience and necessity require that the Noise Element of the General Plan, as amended, together with the maps, be adopted.

Section 2. The Planning Commission of the City of Arroyo Grande does hereby adopt the Technical Section of the Noise Element in its entirety, plus the Policy Section, excepting those portions pertaining specifically to other cities of the County.

Section 3. The Planning Commission Chairman is authorized and directed to certify this approval upon the Noise Element of the General Plan as amended and forward to the City Council for consideration.

On motion by Commissioner Cole, seconded by Commissioner Mathews, and by the following roll call vote, to wit:

AYES: Commissioners Cole, Gerrish, Mathews, Moots, Ries, and Chairman Pope

NOES: None

ABSENT: None

ABSTAINING: Commissioner Hitchen

the foregoing Resolution was adopted this 21st day of September 1976.

ATTEST: /s/ Carol Bento
Secretary

/s/ Hugh O. Pope, Jr.
Chairman

RESOLUTION NO. 1255

A RESOLUTION OF THE CITY COUNCIL OF THE CITY OF ARROYO GRANDE ADOPTING THE NOISE ELEMENT OF THE GENERAL PLAN.

WHEREAS, the Planning Commission of the City of Arroyo Grande has prepared a general plan report, together with general plan maps, entitled the "Noise" plan required by Government Code Section 65302 (g); and

WHEREAS, pursuant to Government Code Section 65503, et seq., the City Council gave required notice and did hold a public hearing on October 12, 1976, for the purpose of considering the adoption of the Noise Element of the General Plan report and maps, and at which public hearing the Noise Plan, reports and maps were displayed, explained and reported upon; and

WHEREAS, said Noise Element of the General Plan report and maps thereof are necessary for sound future community development,the preservation of community values, and the promotion of the general health, safety, convenience and welfare of the citizens of the City of Arroyo Grande; and

WHEREAS, the City Council of the City of Arroyo Grande has a responsibility to plan for the desirable future growth and development of the City of Arroyo Grande.

NOW, THEREFORE, THE CITY COUNCIL OF THE CITY OF ARROYO GRANDE DOES HEREBY RESOLVE AS FOLLOWS:

Section 1. The City Council of the City of Arroyo Grande does hereby find and determine that the public interest, convenience and necessity require that the Noise Element of the General Plan, as amended, together with the maps, be adopted.

Section 2. The City Council of the City of Arroyo Grande does hereby adopt the Technical Section of the Noise Element in its entirety, plus the Policy Section, excepting those portions pertaining specifically to other cities of the County.

On motion of Councilman Spierling, seconded by Councilman Gallagher and on the following roll call vote, to wit:

AYES: Councilmen Spierling, Gallagher, Schlegel, Millis and Mayor de Leon.

NOES: None

ABSENT: None

the foregoing Resolution was passed and adopted this 12th day of October 1976.

/s/ Gabe de Leon
MAYOR

ATTEST: /s/ Ines A. del Campo
CITY CLERK

I, Ines A. del Campo, City Clerk of the City of Arroyo Grande, County of San Luis Obispo, State of California, do hereby certify that the foregoing Resolution No. 1255 is a true, full and correct copy of said Resolution passed and adopted by the City Council of the City of Arroyo Grande at a regular meeting of said Council held on the 12th day of October, 1976.

WITNESS my hand and the Seal of the City of Arroyo Grande affixed this 13th day of October, 1976.

/s/ Ines A. del Campo
City Clerk of the City of Arroyo Grande

(SEAL)

I. INTRODUCTION

A. Legislative Authority

In making city and county governments in California responsible for a Noise Element in their General Plans, the Legislature has recognized the steady escalation of outdoor noise as a significant environmental hazard. Unlike other hazards faced by California residents, such as earthquakes or floods, noise is generated primarily by man's own activities. Considering noise in the planning process, then, is essential to controlling its impact on the community. Specific authority for this Element of the General Plan is contained in Government Code Section 65302(g), which requires the following:

> (g) A noise element in quantitative, numerical terms, showing contours of present and projected noise levels associated with all existing and proposed major transportation elements. These include but are not limited to the following:
>
> (1) Highways and freeways,
> (2) Ground rapid transit systems,
> (3) Ground facilities associated with all airports operating under a permit from the State Department of Aeronautics.
>
> These noise contours may be expressed in any standard acoustical scale which includes both the magnitude of noise and frequency of its occurrence. The recommended scale is sound level A, as measured with the A-weighting network of a standard sound level meter, with corrections added for the time duration per event and the total number of events per 24-hour period.
>
> Noise contours shall be shown in minimum increments of five decibels and shall be continued down to 65 dB(A). For regions involving hospitals, rest homes, long-term medical or mental care, or outdoor recreational areas, the contours shall be continued down to 45 dB(A).
>
> Conclusions regarding appropriate site or route selection alternatives or noise impact upon compatible land uses shall be included in the General Plan.
>
> The state, local, or private agency responsible for the construction or maintenance of such transportation facilities shall provide to the local agency producing the general plan a statement of the present and projected noise levels of the facility, and any information which was used in the development of such levels.

B. Purpose and Approach

As a mandated part of the General Plan, the Noise Element is intended to serve as the local government's guide in public and private development matters related to outdoor noise. The basic goal of the Element is to outline a comprehensive plan to achieve and maintain a noise environment that is compatible with a variety of human activities in different land uses. To achieve this goal, the Element provides a quantitative estimate of noise exposures, land use noise standards, and recommended policies for controlling noise. This information is intended for use in conjunction with other adopted policies of the General Plan, particularly those of the Circulation, Land Use, and Housing Elements.

This Regional Noise Element has been prepared in two volumes for the Area Planning Council. The first volume, the Policy Report, is concerned with the implications of the technical findings for noise control. The second volume, the Technical Report, contains the quantitative

estimates of existing and forecasted noise levels in the Cities and County, and documents the methods used in computing noise exposure. Together, these two volumes constitute the Noise Element.

The reports have been designed for adoption by the County of San Luis Obispo and all of the incorporated cities within the County. The heart of the Element is in the recommended goals, policies, and implementation measures. This section of the Policy Report is therefore organized into chapters by jurisdiction. Each City and the County would then adopt its own policy statement, the preliminary sections of this Policy Report, and the Technical Report. It is intended that once adopted, the Noise Element will be updated on a regular basis.

C. Relationship to Other General Plan Elements

The Noise Element is most closely related to the Circulation, Land Use, and Housing Elements. The principal noise sources evaluated in the Element are transportation noise sources, which are road, rail and air traffic. Noise generated by these sources depends primarily on the number and type of vehicles in operation as planned for in the Circulation Element.

Inseparable from the circulation considerations in the General Plan are the locations and types of land uses throughout the County. The locations of circulation routes in relation to different land uses can be a major determining factor of noise exposure. It is important that consideration be given in the Land Use Element and all community general plans to separating the most noise sensitive land uses from the sources of high noise levels. Land use noise standards are recommended as a part of this Element to assist in these considerations.

The Housing Element is related to the Noise Element in that both the location and insulation requirements of housing are, in part, determined by noise exposures.

The status of the Circulation, Land Use, and Housing Elements of the General Plans of member jurisdictions of the Area Planning Coordinating Council varies from jurisdiction to jurisdiction. Some elements are fairly old, others are recently adopted, and others are in preparation at this time. For those jurisdictions with adopted elements, it is recommended that those elements be reviewed to incorporate this Noise Element. For those jurisdictions whole elements are in preparation, it is recommended that the Noise Element be incorporated into them while under preparation.

II. NOISE EXPOSURE

A. General

The existing and forecasted noise levels in San Luis Obispo County are presented in the Technical Report in both graphic form on the Noise Contours Maps and tabular form in Appendix C of that volume. These noise levels are expressed in A-weighted decibels in terms of Day-Night Noise Levels (abbreviated L_{dn}). Detailed explanations of L_{dn} noise levels and the methods used to compute them are presented in the Technical Report. The following brief discussion is intended to provide a basic understanding of the terms to facilitate use of the Noise Contours Maps and Appendix C. Appendix A of the Technical Report provides a glossary with additional discussion of some of the more technical language.

Common noises experienced by each of us daily may range from a whisper to a locomotive train passing by. The range of sound energy represented by these two events is so large that it cannot be represented mathematically without using numbers in the millions and billions. To avoid this inconvenience, sound levels have been compressed in a standard logarithmic scale called the decibel (dB) scale. The reference level for the scale, 0 dB, is not the absence of sound, but the weakest sound a person with very good hearing can detect in a quiet place. The most important feature of the decibel scale is its logarithmic nature. An increase from 0 to 10 dB represents a tenfold increase in sound energy, but an increase from 10 to 20 dB represents a hundred fold increase, and from 20 to 30 represents a thousand fold increase over 0 dB.

The average range of sounds that we are commonly exposed to generally fall in the 30 to 100 dB range. However, not all sound waves affect us equally. The human ear is more sensitive to high pitch sounds, such as a whistle, than it is to low pitch sounds, such as a drumbeat.

To account for this effect in noise measurements, it is necessary to use an electronic filter in sound level meters which acts as the equivalent of the human ear in filtering out some of the lower frequencies of sound. This filter is called the A-scale weighting network, and is abbreviated by the A in the notation dBA.

A-scale decibel measurements can be taken at any time in the community to record the sound levels of various noise sources. However, to develop an indicator of varying sound levels occuring over the 24-hour day, it is necessary to average the sound occuring at each moment throughout the day. The Day-Night Noise Level is the result of this procedure, and gives a general, single-number index of noise exposure over an average 24-hour day. In computing the L_{dn} levels, it is also necessary to apply a weighting to noise that occurs at night to account for the greater sensitivity that people have to noise at night. L_{dn} noise levels can be developed for road traffic, as well as for rail and air traffic for which the measure has been used traditionally. As examples of typical L_{dn} noise level ranges, Figure 1 gives ranges of L_{dn} decibel exposures ranging from quiet rural areas to an area under the flight path of a major airport.

B. Existing Conditions

The existing noise environments in San Luis Obispo County and the Cities within the County are composed of sounds from many sources. Under the scope of this Element, the noise sources evaluated were road, rail, and air traffic, and stationary noise sources. Parks, schools, and hospitals were also evaluated as noise sensitive land uses to determine if potentially incompatible noise levels impinged on them. The following are summary conclusions regarding the existing noise environment in the County and Cities:

1. In general, San Luis Obispo County may be considered a relatively quiet environment even within most of its Cities and unincorporated urban areas. In all jurisdictions

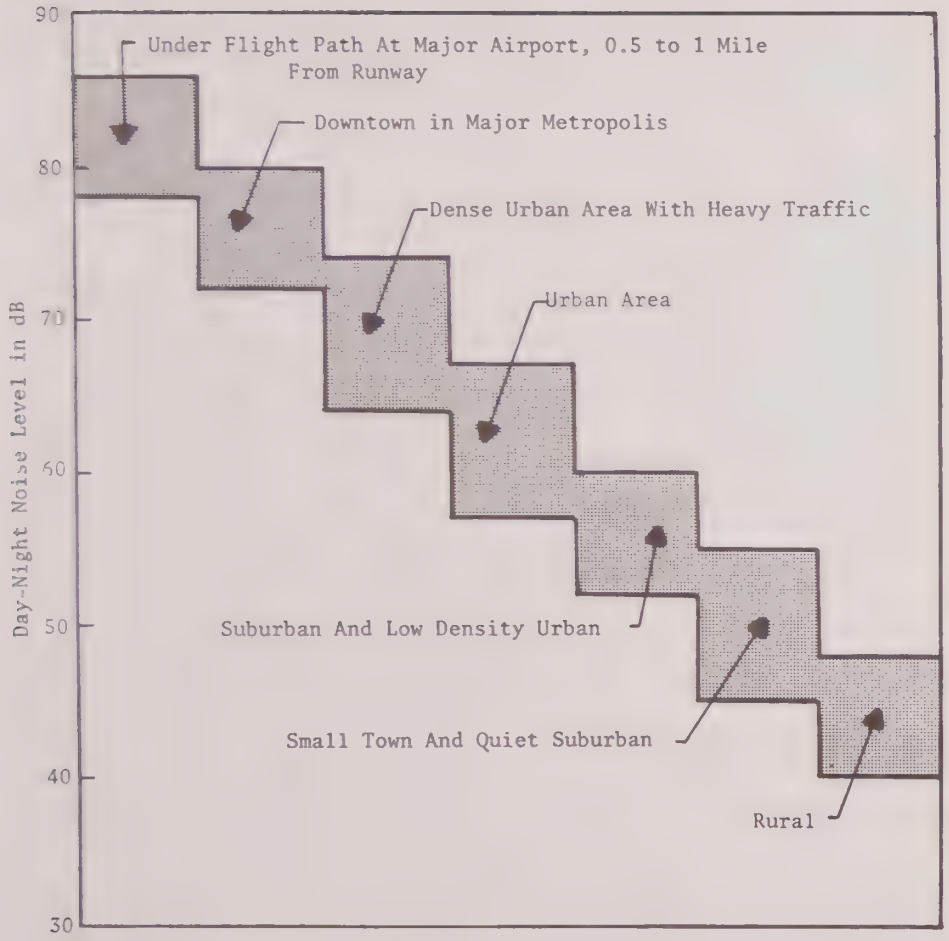


Figure 1

TYPICAL L_{dn} NOISE LEVEL RANGES

(Source: Bolt, Beranek, and Newman, Inc., 1974)

within the County, 14 potential noise conflict areas were identified from a list of 115 possible problem areas. Of 140 possible stationary noise sources investigated, 10 were identified as major noise sources. Of hundreds of road segments evaluated for traffic noise, segments on five principal roadways were associated with high noise levels. This is not to say that the County is without noise problems. Rather, the major noise sources are few in number and of limited impact.

2. The most significant sources of noise in the County is road traffic, followed by rail and air traffic. Stationary noise sources were not found to be significant sources of noise within the County.

3. Of the roads evaluated for noise exposure, the following were found to be associated with high noise levels: U S 101, State Highways 1, 41, 46, 227, El Camino Real in Atascadero, Spring Street and 24th Street in Paso Robles, Morro Bay Boulevard in Morro Bay, Grand Avenue in Grover City, Grand Avenue and Valley Road in Arroyo Grande, and the following roads in the City of San Luis Obispo: Madonna Road, Foothill Boulevard, Santa Rosa Street, Monterey Street, and Johnson Avenue.

4. Rail traffic on the Southern Pacific line is infrequent, but creates intense noise events such that the total sound energy associated with the railroad is nearly equivalent to that of U S 101. Urban areas impacted by railroad noise include the City of Paso Robles, Atascadero, the City of San Luis Obispo, the City of Pismo Beach, Grover City, and Oceano.

5. The three public airports in the County are significant sources of local noise. However, under existing conditions, high noise levels (i.e. 65dBA CNEL or higher) are limited to airport property.

6. Table 1 contains a list of those noise sensitive land uses which were found to be exposed to potentially incompatible noise levels according to the land use standards recommended in this Policy Report. The incompatibility is termed potential because the land use was evaluated only at a general level. Site acoustic analysis is necessary to determine the nature and extent of a noise problem, should one be confirmed to exist. Sources of the noise impinging on the land use or facility are also listed.

Table 1. Potential Noise Conflict Areas

Jurisdiction	Noise Sensitive Area	Local Noise Source
City of San Luis Obispo	French Hospital	Johnson Avenue Southern Pacific Railroad
	County Hospital	Johnson Avenue
	Laguna Lake Park Site	Madonna Road
	Sinsheimer Park	Southern Pacific Railroad
	San Luis Obispo Senior and Junior High Schools	Southern Pacific Railroad
City of Paso Robles	Pioneer Park	U S 101 Southern Pacific Railroad
	Robbins Field Ball Park	Southern Pacific Railroad

Table 1 (Continued)

Jurisdiction	Noise Sensitive Area	Local Noise Source
City of Morro Bay	Lila H. Keiser Pk.	State Highway 1
	Morro Bay Rest Home	State Highway 1
City of Pismo Beach	North Beach Campground	State Highway 1 U.S. 101
	Pismo Creek Park	Southern Pacific Railroad
City of Arroyo Grande	El Camino Wayside Pk.	U.S. 101
	Dower Park	U.S. 101

C. Future Conditions

In planning for noise control, it is necessary to estimate what the future noise environment may be like. Accordingly, noise level forecasts for the year 1995 were included as part of the technical analysis. In general, the future noise environment will be controlled by two factors:

1. The expected increase in the number of noise sources (i.e. traffic volumes), and

2. the application of noise control technology to various sources.

It is reasonable to assume that noise control technology will be applied to some noise sources, and that this will

counterbalance the increase in traffic, resulting in the same noise levels as currently exist or in decreased noise levels. No major technological breakthrough is foreseen for other noise sources, however, such as light aircraft, and the expected increase in volumes of these sources will mean an increase in noise levels. Even with the application of technology, high noise levels are expected to persist in some areas of the County. There are limits to what can be accomplished by technology alone, and this makes land use control a necessary component of successful noise control strategies. Summary conclusions regarding the expected future noise environment are as follows:

1. Forecasts of road traffic noise assume that noise control technology will be applied, and that this will counteract the expected increase in road traffic in most, but not all, cases. Thus road traffic noise is projected to remain the same or decrease somewhat by 1995 on most roads.

2. The future of the railroad is in a state of flux at this time, making the task of quantitative noise projection impractical. Current noise levels are assumed to persist for at least the intermediate future.

3. No major technological breakthrough is foreseen which will significantly reduce the noise emissions of reciprocating engine aircraft. Noise levels around the three public airports are, therefore, expected to increase in the forecast year due to increases in traffic. However, even these increased noise levels will not significantly affect land outside the airport property except in the case of San Luis Obispo Airport.

4. Stationary noise sources are expected to continue to emit existing noise levels unless abatement is required by local or federal agencies.

D. Effects of Noise

1. General

Noise affects man and his environment in a number of important ways. Some sounds cannot be heard or are not noticed, yet the human body reacts involuntarily to them. Other sounds are intense and quick enough to rupture the eardrum. However, all sound is not destructive. The point should be emphasized that sound is vital to communication and necessary for the maintenance of life.

As sound levels increase, they quickly reach levels which can be detrimental to health and well-being. However, like most human characteristics such as eye color and vision acuity, hearing ability is distributed "normally" in a population. That is, there are a few people with extremely sensitive hearing, and a few people with extremely poor hearing ability. Most people, however, have hearing abilities between these extremes. This is an important concept to remember while reading the following sections on the effects of noise. Not all people are subject to experiencing these effects to the same degree. In short, the effects of noise are subjective, and this has an important bearing on regulatory schemes enacted by governments which set noise standards.

The effects of noise may be thought of as falling into four categories: physical, psychological, social, and economic. The lines between the categories are not established; there is much overlap. As research in acoustics and human response to sound progresses, the effects of noise will be more completely defined. This discussion is intended to be a brief summary of existing knowledge.

2. Physical

The most serious physical effect of noise is damage to

hearing, and the most tragic damage to hearing is a permanent shift in the hearing threshold (termed permanent threshold shift or PTS). Once the cells of the inner ear are ruptured or otherwise damaged, there is no known way to repair them. The cells do not regenerate. To persons intermittently exposed to high noise levels, the hearing threshold may be shifted temporarily (termed temporary threshold shift or TTS). Most of us have experienced TTS at sometime, for example, when a firecracker explodes or a loud, sharp noise occurs nearby. For awhile, we cannot hear sounds at lower intensities. While the ear eventually recovers from this kind of damage, TTS can be a significant problem to persons frequently exposed to noise.

Besides the physical effect on our hearing, noise can induce a number of other physiological reactions. In fact, environmental or community noise is of concern not so much because of its effects on hearing, but because of its non-auditory effects. Community noise, particularly in a predominantly rural area such as San Luis Obispo County, is usually not intense enough to affect hearing. Table 2 is a summary of the noise level criteria, based on hearing loss, established by the Walsh-Healey Public Contracts Act of 1969 and the Occupational Safety and Health Act of 1970 (OSHA). These criteria are intended to regulate noise levels in industrial settings where people are exposed on a daily basis over a lifetime. To experience the 90 dBA criterion from road traffic, a person would have to stand 10 to 20 feet from a highway carrying about 1000 trucks per hour. To meet the OSHA criteria, the person would have to remain there 8 hours a day for a period of at least several years. Such a situation is highly improbable (even with the expected 5 dBA reduction in the OSHA criteria) and indicates that few, if any, people in San Luis Obispo County are exposed to noise levels from transportation sources that can significantly damage hearing.

Table 2. Hearing Damage Risk Criteria

Duration per day, hours	Sound level, dBA
8	90
6	92
4	95
3	97
2	100
1½	102
1	105
½	110
¼ or less	115

Source: Walsh-Healy Public Contracts Act of 1969

Perhaps the most important effects of community noise, then, are its effects related to stress. Noise is one of the principal urban stresses experienced daily by urban dwellers. The body interprets noise as a form of stress and reacts accordingly. Most of the responses are automatically produced by the involuntary nervous system. The individual may not be consciously aware that his body is under stress, and that nervous reactions are occuring. Furthermore, the individual may not be aware that noise is the source of stress even if he was aware of the stress in the first place. Reactions to noise are similar to reactions to intense emotional states such as fear or anger. Some of the responses are (1) an increase in blood pressure, (2) an increase in heart rate, (3) dilation of the pupils, (4) increase in blood cholesterol, (5) increase in hormone levels by endocrine glands, (6) change in the rate of acid secretion by the stomach, (7) increase in sweat gland activity, and (8) increase in respiration. These responses can lead to increases in heart disease, ulcers, tension, hypertension, and allergic reactions. It has been documented that noise affects us even in the womb

before birth. Even relatively low levels of noise in the mother's environment can cause the fetus' heart rate to increase significantly. Other research concludes that very loud noises can possibly be as much a cause of congential malformations as thalidomide or German measles. On a less serious level, noise can be responsible for the headaches and daily fatigue common in urban areas. Noise may affect our health adversely only if we are exposed to high levels for long periods of time, but it can impair our well-being through the kind of effects listed above at levels commonly experienced in urban areas.

The effects of noise discussed above are produced by sounds in the audible frequency range. Mention should also be made of two categories of sound which cannot be heard - "ultrasonics" and "infrasonics". Ultrasonics refers to the range of sounds above 20,000 Hertz or wave cycles per second, the upper limit of human hearing. A dog whistle is a common example of a device which produces ultrasonic frequencies. Infrasonics, on the other hand, refers to frequencies below the audible range, that is, below 16 Hertz.

For years, ultrasound has been used in medicine to treat asthma, cycstic fibrosis, and other respiratory ailments, and in a variety of ways to clean small instruments, jewelery, tools, dentures, etc. Useful and common as ultrasound is, it is known to be hazardous if improperly applied. It specifically should not be directed at areas of poor blood circulation or cancerous infection. The presence of ultrasound in the ambient urban atmosphere is generally insignificant compared to audible frequencies, but it should be noted as a potential health hazard.

Infrasound is less familiar to most people, and research into the world of infrasonics is relatively recent. These low frequency pressure waves seem mostly to act on the internal organs - the heart, lungs, and viscera - by vibrating them. The organs are rubbed together by a kind of resonance creating dizziness, nervous fatigue, and seasickness. A frequency of 7 Hz. has been found to be fatal at high enough intensities. Infrasound has been measured in the everyday ambient atmosphere in Washington D.C. Some of the sources were identified as large scale natural events such as tornadoes in Oklahoma, an earthquake in Montana, and magnetic storms in the upper atmosphere. A large number of sources remain unidentified, however. One common source of infrasound are large industrial ventilation systems. More so than ultrasound, infrasound can be considered part of the urban environment.

Noise affects animal behavior in ways similar to human behavior. Little research has been done in this field, expecially on wild animals, but there are strong indications that unfamiliar noises can disrupt population dynamics and individual growth behavior. A single startle can stop the brooding cycle of wild game birds. Continuous noise can mask predator-prey signals inducing huddling, panic, or migration. Animal ears are subject to similar kinds of physical damage as human ears. Loss of hearing because of noise exposure has been documented in a number of laboratory cases with a variety of species. Animals also react to noise as stress which produces neural and hormonal changes affecting urinary, adrenal, and reproductive functions.

In the wild, these effects can significantly alter the "natural balance" between various species and between species and their environment. An animal which depends on hearing to locate prey could starve if its auditory function was impaired. Mating signals could be interfered with, and distress signals may be masked by background noise. All of these effects can lead to increased mortality rates.

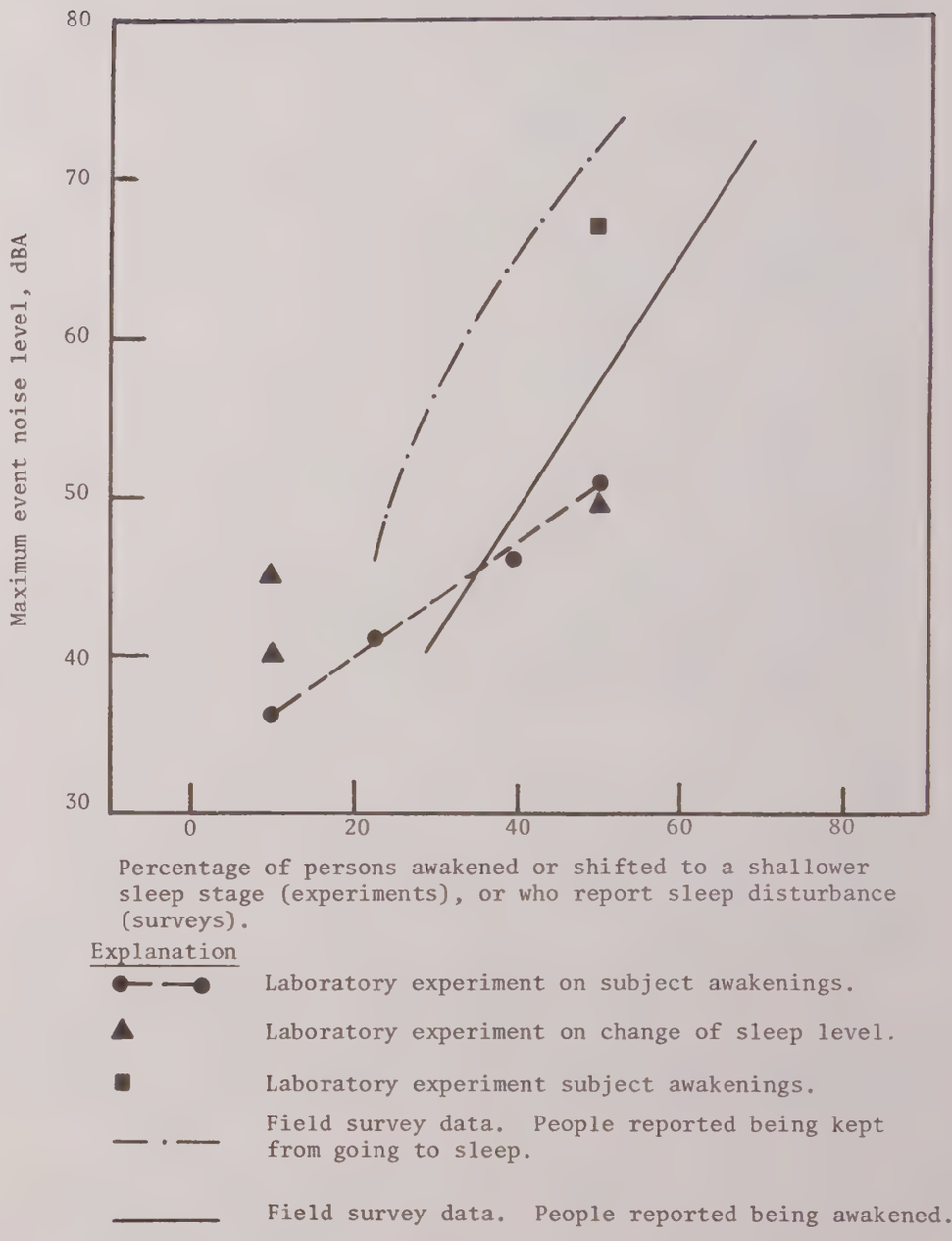
Domestic animals may suffer more since they are usually closer to urban areas. Farm animal productivity may be diminished, and mortality rates can be increased as well. The economic impact of these effects would make further study in this area worthwhile. The point to be made is that noise impacts the animal population in San Luis Obispo County, as well as the human population. It should also be noted that animal populations have adverse reactions primarily to unfamiliar noises. Animals demonstrate an ability to adapt to a noise over time if it is learned that the noise is not associated with direct harm.

Noise also affects the non-living physical environment in the City. The example of high pitched sound resonating and shattering glass is common. Structural damage by noise is usually moderate, however, even in sonic booms. Glass and plastic are generally the materials most susceptible to damage by noise. Others include base coats of paint, finish coats, stucco, wallboards, interior tiles, brick, concrete blocks, and organic adhesives. Temporary vibrations may be induced in various kinds of structures, particularly buildings, by noise as well. Structural response to sound is highly variable, however, and most damage is usually concentrated in secondary structures such as glass or plaster.

3. Psychological

It is difficult to distinguish between physical and psychological effects of noise. Many of the behavioral responses to noise are rooted in the involuntary physiological reactions. The two most serious psychological effects of noise are interference with sleep and speech. Data on interference with sleep shows that this response is more subjective than interference with speech, but generally noise levels will begin to interrupt or impair sleep in the 40 to 45 dBA range (Figure 2). Noise acts on the body when it is asleep in the same manner as it does when the person is awake. The ear does not mask noise during sleep. Even if noise levels do not awaken

Figure 2. Noise-induced sleep disturbance data.
(Source: Wyle Laboratories, 1973)



a person, they can interfere with dream stages shifting a person from a deeper dream stage to a shallower one. Any disruption of deep stage dreaming is thought to impair mental health and well-being. Loss of sleep is known to impair a person's ability to carry on normal daily tasks, especially those requiring short term memory or high speed processing of information. Severe deprivation of sleep can create irascibility and mental disorganization causing dreaming while awake, hallucinations, and other behavior bordering on temporary mental illness. It is important to remember that noise can disturb the rest of sleeping persons whether they awaken or are aware of the noise or not.

Interference with speech depends, of course, on how far the people are from each other, the level of their voices and other parameters. The understandable reception of voice sounds in ordinary conversation is usually interfered with at the level of 50 to 60 dBA (Figure 3). The social costs of interference with speech can be of great magnitude and are discussed below. The behavioral impacts of speech interference include impairment of leisure activities needed for stable human behavior, and irritability when conversations must stop until the noise decreases. Noise also interferes with concentration and the ability to perform tasks.

While it has never been proven that exposure to noise alone can cause mental illness or breakdown, it is true that exposing a depressed individual to noise doesn't help. A famous English study reported in 1969 that individuals closely exposed to the noise of London's Heathrow Airport had higher admission rates to mental hospitals than people living farther from the noise. Such evidence is not entirely convincing, but does warrant further investigation. It is a good indication that noise, as an additional form of unwanted stress, can provide the increment to bring on emotional crises.

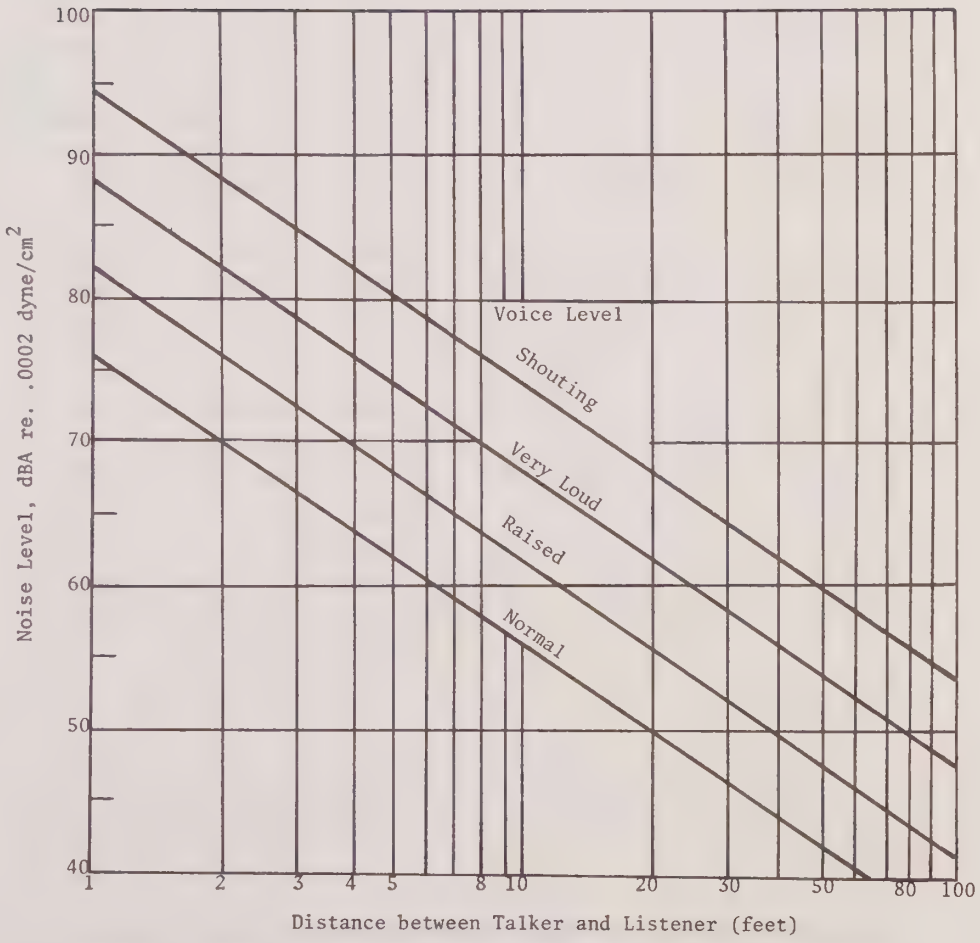


Figure 3. Noise levels which barely permit face-to-face conversation at the indicated distances (Source: Wyle Laboratories: 1973).

4. Social

The reactions of groups and communities to noise are similar to the reactions of individuals. It is clear that noise interferes with social processes. Its foremost effect is to disrupt the ability of people to communicate with one another. Communication by sound is vital to almost all human social behavior, and its impairment should not be underestimated. As an important example, consider educational processes. Children who attend school near sources of loud noise can have their learning and socialization processes severely handicapped. Several schools in Westchester were forced to close down because the noise near the Los Angeles International Airport interfered so seriously with teaching. The effects of noise on other social processes such as marketing, recreation, and the practice of religion can be equally as serious.

5. Economic

One of the more prevalent economic effects of noise of concern to San Luis Obispo is the reduction of residential property values near the source of noise. This document does not examine specific property values in any of the member jurisdictions of the Area Planning Coordinating Council, but a comparison of residential property values near the railroad or U S 101 with residential property located away from these sources may bear this out.

One other kind of major economic cost of noise is noise-induced inefficiency in the labor force. As noted under psychological effects, noise interferes with the performance of tasks. Such interference causes business and industry to lose income through lost output. At the national level, such losses total millions of dollars daily. Occupational noise yearly results in hundreds of millions of dollars of compensation claims, and the costs of insulating environments and muffling sources should be included as economic costs as well. Economic costs of noise are among the most difficult to calculate, however, because they are associated with the psychological states of stress discussed above. The effects of these states have yet to be adequately quantified by economists.

6. Local Effects in San Luis Obispo County

It is important to ask whether any of the effects discussed above are occuring locally in any of the member jurisdictions in San Luis Obispo County. Since a specific study of this nature has not been conducted as a part of the Noise Element, it is difficult to give a precise answer. However, health and welfare criteria have been published by the federal Environmental Protection Agency, and these criteria can be compared to the noise levels quantified in this Element to draw some general conclusions.

The basic criteria are given in Table 3, and utilize the Sound Equivalent Level (L_{eq}) and Day-Night Noise Level (L_{dn}). The L_{eq} is the basis for the L_{dn} noise level, but does not include a weighting for nighttime noise. It should be noted also that an "adequate margin of safety" has been built into these criteria.

Table 3

SUMMARY OF NOISE LEVELS IDENTIFIED AS REQUISITE TO PROTECT PUBLIC HEALTH AND WELFARE WITH AN ADEQUATE MARGIN OF SAFETY

(Source: US Environmental Protection Agency, 1974)

EFFECT	LEVEL	AREA
Hearing Loss	$L_{eq}(24) \leq 70$ dB	All areas
Outdoor activity interference and annoyance	$L_{dn} \leq 55$ dB	Outdoors in residential areas and farms and other outdoor areas where people spend widely varying amounts of time and other places in which quiet is a basis for use.
	$L_{eq}(24) \leq 55$ dB	Outdoor areas where people spend limited amounts of time, such as school yards, playgrounds, etc.
Indoor activity interference and annoyance	$L_{dn} \leq 45$ dB	Indoor residential areas.
	$L_{eq}(24) \leq 45$ dB	Other indoor areas with human activities such as schools, etc.

Explanation

$L_{eq}(24)$ - Equivalent A-weighted Sound Level over a 24-hour period.

L_{dn} - Day-Night average sound level - the 24-hour A-weighted Equivalent Sound Level, with a 10 decibel penalty applied to nighttime levels.

dB - decibels.

Judging by these criteria and the noise levels quantified in the Technical Report, most of San Luis Obispo County and the Cities within the County are free of the effects of noise. Near the major roads, the railroad, and the airports, however, these criteria indicate that a certain level of activity (i.e. sleep, speech) interference and stress can be expected. As noted in a previous section, it is unlikely that any resident's hearing is threatened unless he is spending unusually long periods of time in close proximity to the major highways.

III. NOISE CONTROL

A. Noise Regulations

Heightened concern in recent years for "environmental quality" has led to greater attention by the legislative and administrative branches of government to the problem of excessive noise. This attention has resulted in the enactment of a number of laws and regulations regarding noise. To provide the legal and planning contexts within which the recommended goals and policies of the Element would be implemented, this section summarizes the current noise laws and outlines possible noise control strategies.

Unfortunately, there has been little coordination among the agencies responsible for noise control, and this has resulted in the use of different noise evaluation techniques and standards in noise regulations. This non-uniform approach makes comparison and use of standards and regulations a confusing matter for both the general public and those government officials responsible for compliance at the local level. Table 4 provides a summary list of existing noise regulations which pertain to the member jurisdictions of the Area Planning Coordinating Council. In addition to those laws shown in the table, both the National Environmental Protection Act (NEPA) and the California Environmental Quality Act (CEQA) require environmental analysis of certain developments including an analysis of potential noise problems at the project site.

The most significant of the laws listed in Table 4 is the Noise Control Act of 1972. This law essentially authorizes the EPA to coordinate noise regulation at the national level. It also authorizes the EPA to set noise emission limits for major noise sources including aircraft, motor vehicles, and trains. These emission standards can be expected to have an important effect on future noise levels in the County. In addition, health and welfare criteria for noise exposure limits have been published in compilance with the Act, and these criteria have been incorporated into the recommended land use compatibility standards. In publishing these criteria, the EPA has selected and recommended the L_{dn} measurement scale for use as a uniform noise evaluation scheme. If nationwide use of this measure becomes a reality, much of the existing confusion regarding noise should diminish. This should enable the various Cities and the County to enact noise control regulations and measures consistent with one another, as well as with the State and Federal government.

B. Alternative Noise Control Strategies

Any action to control noise will work on either the source of the noise, its transmission path, the receiver of the noise, or any combination of these facets of sound. As noted in the preceding section, source controls are primarily the responsibility of the federal government, and to a lesser degree, the state government. Control of the reception of noise, however, has its roots in local government's traditional authority over land use control.

The basic goal of this Element is to achieve and maintain a noise environment that is compatible with a variety of human activities. This clearly calls for cooperation among all levels of government. Source controls are the most effective means of reducing noise, but there are limits to what can be accomplished through technology alone. A need for land use controls, coupled with source controls, will probably be necessary for overall noise reduction in many cities for the forseeable future.

The purpose of this section of the Noise Element is to outline some of the land use and other types of noise reduction alternatives that are available for implementation by the County and Cities. These various strategies form the basic planning framework for the recommended goals and policies of the next sections.

TABLE 4

EXISTING FEDERAL AND STATE NOISE REGULATIONS

	Responsible Agency	Regulation/Standard	Noise Source Regulated	Summary
FEDERAL	Environmental Protection Agency	Public Law 92-574 (Noise Control Act of 1972)	All	Gives EPA responsibility to identify noise sources, set standards for limiting emissions, publish health and welfare criteria, set product labeling standards, and recommend aircraft standards.
	Federal Aviation Administration	FAR Part 36	Aircraft	Sets emission limits for aircraft under specified flight conditions for type certification.
	Federal Highway Administration	PPM 90-2	Highways, outdoor noise environment	Sets land use compatibility requirements for developments adjacent to Federal-aid highways.
	Department of Housing and Urban Development	Policy Circular 1390.2	Airports, outdoor noise environments	Sets noise acceptability requirements for developments requesting Federal loan assistance.
STATE OF CALIFORNIA	Department of Aeronautics (Caltrans)	California Administrative Code, Title 4, Sub-chapter 6	Airports, Aircraft	Specifies maximum noise exposures for sensitive uses near airports; sets standards for aircraft operations.
	Department of Motor Vehicles	California Vehicle Code Section 23130	Motor Vehicles	Sets noise emission limits for motor vehicles under specified operating conditions.
	Department of Transportation (Caltrans)	Streets and Highways Code	Highways	Requires corrective action when noise levels exceed set limits in nearby schools.

TABLE 4

(Continued)

	Responsible Agency	Regulation/Standard	Noise Source Regulated	Summary
STATE OF CALIFORNIA	Commission of Housing and Community Development	California Administrative Code, Title 25, Article 4	Outdoor/Indoor noise environments	Limits interior noise levels resulting from outdoor levels in new multi-family units.
	Council on Intergovernmental Relations	California Government Code, Section 65302(g)	Outdoor noise environment	Requires quantitative Noise Elements in all City and County General Plans.

Generally, noise control strategies may be thought of a belonging to one of three approaches. From least restrictive to most restrictive, these strategies are: (1) to encourage voluntary noise reduction measures by property owners and developers, (2) require noise reduction or compatible land use through zoning and planning powers, and (3) enact noise control through government ownership of the affected property.

The first approach would include providing information to builders and the general public regarding the importance of noise reduction and different construction and site development techniques for noise compatibility. Various means of achieving this objective include review of proposals by an architectural review board, design services by government staff during the permit application process, and maintenance of an acoustical information library for developers and the public. Education of the public is an important aspect of this approach since public awareness of noise problems can affect the marketability of developments. Such an approach can be successful in solving noise problems provided there is a degree of cooperation between the local government and developers or if the development market is a buyer's market and there is a demand for noise compatibility.

If these conditions do not exist, it may be necessary to use the local government police powers of zoning and planning to ensure that the public is protected from excessive noise. These measures can be an important influence on future development, but may be of little help in resolving existing noise problems. The basic approach is the exclusion of noise sensitive land uses from areas of high noise levels. If development is permitted in noise-impacted areas, zoning performance and development standards can regulate the details of the development such as building height, buffer areas, and noise barrier construction. Special types of development, such as cluster housing and planned unit developments, can be regulated to prevent unnecessary noise problems from occurring. Building codes may be enforced under this approach as well to limit the transmission of sound into and out of buildings. One concept being implemented in a number of cities in California and across the US is the adoption and enforcement of a noise ordinanance which sets quantitative limits on the level of noise permitted in different zones in the City.

Short of purchasing land, the local government can also use tax incentives to regulate land development to a certain degree. This is a potentially powerful land use control which can reduce development pressure on vacant land. The basic technique is to reduce the assessed value of land in noise impacted areas so that landowners are not pressured into selling land they can no longer afford to pay taxes on. This approach has been used in California to preserve open agricultural land under the Williamson Act with varying degrees of success.

Government ownership of noise-impacted land makes the regulation of its use a simpler matter, but the acquisition of the property can be expensive and unpopular locally if eminent domain is used. Purchase or the use of eminent domain powers can be avoided through purchase of an easement regulating the land witout transfer of ownership.

Which of these three approaches is used, depends in large measure on the severity of the noise problem. The Technical Report of this Element concludes that, for the most part, San Luis Obispo County is free from excessive noise levels from rail and road traffic except in close proximity to certain major sources such as US 101 and the Southern Pacific railroad tracks. It is unlikely, then, that the local governments need to consider the most restrictive approach, and can rely on zoning and planning to prevent major noise problems from occurring near these sources.

All of the above strategies deal primarily with reducing future noise problems rather than existing ones. Where a noise problem already exists, one or more of five solutions are available: (1) the noise can be reduced at the source, (2) the noise can be blocked by an insulating barrier, (3) the source can be removed from people and other receivers, (4) the receiver can be removed from the source, or (5) the time exposure to the noise can be minimized. As is true with most environmental hazards, preventing or reducing the cost of the future hazard is easier and less expensive than resolving existing problems. Special ordinances can be adopted, however, which set noise limits by land use zones, and which require compliance by existing developments. One of the central problems of setting noise limits by zone is the number of desirable exceptions to the established noise limit.

IV. GOAL AND POLICY RECOMMENDATIONS

A. Organization of Recommendations

The previous sections of this report provide a summary of the technical analysis of noise in San Luis Obispo County, and a synthesis of the legal and planning frameworks for noise control. In this section, general planning goals and policies are recommended for each of the member jurisdictions. These recommendations constitute the noise control plan of the County and Cities, and are the heart of the Noise Element. They have been organized by jurisdiction for purposes of the adoption process in the County and Cities.

The recommendations comprise a general planning goal, general policies, and more specific policies termed implementation measures. The general goal provides a statement of the basic purpose of the Noise Element so that consistent planning is possible. It is a necessary guideline which can be held up against future proposals to determine their effect on the noise environment. The general policies complement the planning goal and define specific directions for jurisdictions to take in controlling noise. The implementation measures are a refinement of the general policies, and recommend specific actions for carrying out those policies.

While it would be desirable to fully implement each of the recommended policies and implementation measures, it is recognized that unlimited resources to that end are not available. To aid in determining priorities for the allocation of resources in the community, the recommendations are listed below in their general order of importance to achieving the goal of the Element.

B. County of San Luis Obispo

1. Goal

It is the goal of the County of San Luis Obispo to ensure that its residents are free from excessive noise and abusive sounds. Primary emphasis should be placed on protecting the general public from noise levels which may be hazardous to hearing. Secondary emphasis should be the minimization of noise-induced stress, annoyance, and activity interference.

2. Policies

1.0 Land use noise compatibility standards should be established for general planning and zoning purposes.

2.0 Provision should be made for the identification and evaluation of potential noise problem areas.

3.0 Existing and potential incompatible noise levels in problem areas should be reduced through land use planning, building and subdivision code enforcement, and other administrative means.

4.0 Existing and potential incompatible noise levels in problem areas should be reduced through operational or source controls where the County has responsibility for such controls.

5.0 A program should be developed, for the education of the community in the nature and extent of noise problems in the County.

6.0 Coordinate noise control activities with those of other responsible jurisdictions.

7.0 Provide for periodic review and revision of the Noise Element.

3. Implementation Measures

1.0 Land use noise compatibility standards should be established for general planning and zoning purposes

1.1 The noise comptability standards provided in Figure 4 should be used in identifying potential noise problem areas, and in reviewing environmental impact documents.

1.2 Noise performance standards should be incorporated into zoning and other appropriate ordinances.

2.0 Provision should be made for the identification and evaluation of potential noise problem areas

2.1 A County-wide Noise Contours Map should be developed based on transportation and stationary noise sources.

2.2 Existing land uses should be reviewed to identify potential noise problems.

2.3 An on-going noise monitoring program should be established to identify and evaluate noise levels in the County.

2.4 Noise conflict mapping should be conducted for land use categories not included in this analysis, particularly residential land uses.

3.0 Existing and potential incompatible noise levels in problem areas should be reduced through land use planning, building and subdivision code enforcement, and other administrative means

3.1 Proposed developments in the County should be located on a Noise Contours Map to determine if there is a potential impact on the development or, conversely, if the development will

Figure 4.
LAND USE COMPATIBILITY GUIDELINES

LAND USE CATEGORY	Maximum Interior Exposure, Ldn*	LAND USE INTERPRETATION FOR Ldn VALUE 55 65 75 85
Residential - Single Family, Duplex, Mobile Homes	45	
Residential - Multiple Family, Dormitories, etc.	45	
Transient Lodging	45	
School Classrooms, Libraries, Churches	45	
Hospitals, Nursing Homes	45	
Auditoriums, Concert Halls, Music Shells	35	
Sports Arenas, Outdoor Spectator Sports		
Playgrounds, Neighborhood Parks		
Golf Courses, Riding Stables, Water Rec., Cemeteries		
Office Buildings, Personal, Business and Professional	50	
Commercial - Retail, Movie Theaters, Restaurants	50	
Commercial - Wholesale, Some Retail, Ind., Mfg., Util.		
Manufacturing, Communications (Noise Sensitive)		
Livestock Farming, Animal Breeding		
Agriculture (except Livestock), Mining, Fishing		
Public Right-of-Way		
Extensive Natural Recreation Areas		

*Due to exterior sources
(Source: Bolt, Beranek, and Newman, Inc., 1974)

EXPLANATION

FOR

FIGURE 4

CLEARLY ACCEPTABLE | NORMALLY ACCEPTABLE | NORMALLY UNACCEPTABLE | CLEARLY UNACCEPTABLE

CLEARLY ACCEPTABLE:

The noise exposure is such that the activities associated with the land use may be carried out with essentially no interference. (Residential areas: both indoor and outdoor noise environments are pleasant.)

NORMALLY ACCEPTABLE:

The noise exposure is great enough to be of some concern, but common constructions will make the indoor environment acceptable, even for sleeping quarters. (Residential areas: the outdoor environment will be reasonably pleasant for recreation and play at the quiet end and will be tolerable at the noisy end.)

NORMALLY UNACCEPTABLE:

The noise exposure is significantly more severe so that unusual and costly building constructions are necessary to ensure adequate performance of activities. (Residential areas: barriers must be erected between the site and prominent noise sources to make the outdoor environment tolerable.)

CLEARLY UNACCEPTABLE:

The noise exposure at the site is so severe that construction costs to make the indoor environment acceptable for performance of activities would be prohibitive. (Residential areas: the outdoor environment would be intolerable for normal residential use.)

increase noise levels in a relatively quiet area. The development review and environmental review processes should include a further analysis in areas of potential impact.

3.2 Discourage development of noise sensitive uses in incompatible noise-impacted areas.

3.3 Strictly enforce all existing noise control regulations, including building and subdivison laws.

3.4 In existing or future development in noise-impacted areas, encourage or require through ordinance that adequate site planning and insulation measures are taken to reduce noise to the established levels.

4.0 Existing and potential incompatible noise levels in problem areas should be reduced through operational or source controls where the County has responsibility for such controls.

4.1 Locate routes for use by heavy trucks away from noise sensitive land uses.

4.2 Seek to restrict the type of aircraft allowed to operate at the County Airports if certain aircraft are found to emit excessive noise levels.

4.3 Limit the number of daily operations at the Airports and/or the time of operations if excessive noise results from the operations.

4.4 Implement operational controls (e.g. flight path modification) for specific aircraft if those aircraft emit excessive noise.

4.5 Encourage the Southern Pacific Transportation Company to control its operations to reduce noise impacts on the County.

4.6 Consider noise abatement of stationary sources in cases of excessive noise emissions.

5.0 A program should be developed for the education of the community in the nature and extent of noise problems in the County

5.1 An information release program should be developed to familiarize residents of San Luis Obispo County with the Noise Element and noise problems in general. Special attention should be paid to identifying and informing those people now residing or working in noise problem areas.

5.2 Developers and builders should be provided with specific design information to reduce noise levels in new and existing developments. Consultations with developers should be held during the permit application process regarding potential noise problems.

5.3 A noise information library should be maintained for both the general public and those with technical backgrounds involved in noise control.

6.0 Coordinate noise control activities with those of other responsible jurisdictions

6.1 Encourage the State Department of Transportation (CALTRANS) to incorporate noise reduction methods in new and existing road construction.

6.2 Coordinate noise monitoring activities with those of the Cities within the County, and CALTRANS.

6.3 Encourage the development and use of a uniform noise evaluation scheme at all levels of government.

7.0 Provide for periodic review and revision of the Noise Element

7.1 The Noise Element should be reviewed at least every two years and should be comprehensively revised every five years or whenever major changes in the noise environment occur.

7.2 Upon adoption of the Noise Element, a review committee should be established to oversee its implementation and to report to the Board of Supervisors on implementation progress. This committee should be composed of representatives from the Planning Department, the County Engineering Department, and the general public.

7.3 The Noise Element should be reviewed when revisions or preparation of the following plans or elements occur: Airport Land Use Plan, Land Use Element, Circulation Element, Housing Element, and Community General Plans.

H. City of Arroyo Grande

1. Goal

It is the goal of the City of Arroyo Grande to ensure that its residents are free from excessive noise and abusive sounds. Primary emphasis should be placed on protecting the general public from noise levels which may be hazardous to hearing. Secondary emphasis should be the minimization of noise-induced stress, annoyance, and activity interference.

2. Policies

1.0 Establish land use noise compatibility standards for general planning and zoning purposes.

2.0 Provide for the identification and evaluation of potential noise problem areas.

3.0 Reduce existing and potential incompatible noise levels in problem areas through land use strategies, building and subdivision code enforcement, and other administrative means.

4.0 Reduce existing and potential incompatible noise levels in problem areas through operational or source controls where the City has responsibility for such controls.

5.0 Provide for the education of the community in the nature and extent of noise problems in the City.

6.0 Coordinate noise control activities with those of other responsible jurisdictions.

7.0 Provide for periodic review and revision of the Noise Element.

3.0 Implementation Measures

1.0 Establish land use noise compatibility standards for general planning and zoning purposes

- **1.1 Adopt the noise compatibility standards provided in Figure 4 for use in identifying potential noise problem areas, and in reviewing environmental impact documents.**
- **1.2 Develop a zoning ordinance setting specific noise limits for various land uses.**

2.0 Provide for the identification and evaluation of potential noise problem areas

- **2.1 Using the noise compatibility standards provided in Figure 4, review existing land uses to identify potential noise problems.**
- **2.2 Provide for site analysis of potential noise problem areas.**
- **2.3 Establish an on-going noise monitorning program to identify and evaluate noise levels in the City.**

3.0 Reduce existing and potential incompatible noise levels in problem areas through land use strategies, building and subdivision code enforcement, and other administrative means

- **3.1 Discourage development of noise sensitive uses in incompatible noise-impacted areas close to major noise sources.**
- **3.2 Strictly enforce all existing noise control regulations, including building and subdivision laws.**

3.3 In existing or future development in noise impacted areas, encourage or require through ordinance that adequate site planning and insulation measures are taken to reduce noise to the established levels.

4.0 Reduce existing and potential incompatible noise levels in problem areas through operational or source controls where the City has responsibility for such controls.

4.1 Locate routes for use by heavy trucks away from noise sensitive land uses.

4.2 Encourage the Southern Pacific Transportation Company to control its operations to reduce noise impacts on the County.

4.3 Require noise abatement by stationary sources in cases of excessive noise emissions.

5.0 Provide for the education of the community in the nature and extent of noise problems in the City.

5.1 Develop an information release program to familiarize residents of Arroyo Grande with the Noise Element and noise problems in general. Special attention should be paid to identifying and informing those people now residing or working in noise problem areas.

5.2 Provide developers and builders with specific design information to reduce noise levels in new and existing developments. Consult with developers during the permit application process regarding potential noise problems.

5.3 Maintain a noise information library for both the general public and those with technical backgrounds involved in noise control.

6.0 Coordinate noise control activities with those of other responsible jurisdictions

6.1 Encourage the State Department of Transportation (CALTRANS) and the County Engineer to incorporate noise reduction methods in new and existing road construction.

6.2 Coordinate noise monitoring activities with those of the County and CALTRANS.

6.3 Encourage the development and use of a uniform noise evaluation scheme at all levels of government.

7.0 Provide for periodic review and revision of the Noise Element

7.1 The Noise Element should be reviewed at least every two years and should be comprehensively revised every five years or whenever major changes in the noise environment occur.

7.2 Upon adoption of the Noise Element, a review committee should be established to oversee its implementation and to report to the City Council on implementation progress. This committee should be composed of representatives from the Planning Department, the City Engineer, and the general public.

7.3 The Noise Element should be reviewed when revisions or preparation of the following General Plan Elements occur: Land Use Element, Circulation Element, Housing Element.

THE CITY OF
ARROYO GRANDE
SAN LUIS OBISPO COUNTY, CA

GENERAL PLAN

NOISE
ELEMENT

SCALE 500 1000 1500 2000 2500

1975 NOISE CONTOURS

Explanation

Life Centers, Rural Traffic Noise, dBA

Existing Parks

Existing Schools

Existing Hospitals

Proposed Parks

Potential Noise Conflict Area

TRUCK ROUTE

THE CITY OF
ARROYO GRANDE
SAN LUIS OBISPO COUNTY, CA

GENERAL PLAN

NOISE
ELEMENT

1995 NOISE CONTOURS

Explanation

- Ldn Contour, Road Traffic Noise, dBA
- Existing Parks
- Existing Schools
- Existing Hospitals
- Proposed Parks
- Potential Noise Conflict Area

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Abbreviations

ADT	Average Daily Traffic for a 24-hour day.
ANSI	American National Standards Institute (formerly USASI).
dBA	A-weighted decibel (decibels). Also written dB(A).
EPA	Environmental Protection Agency.
Hz	Hertz or wave cycles per second.
L_{eq}	Equivalent AOweighted sound level over a given time interval.
$L_{eq(8)}$	Equivalent A-weighted sound level over eight hours.
$L_{eq(24)}$	Equivalent A-weighted sound level over 24 hours.
Ldn	Day-night average sound level-the 24 hour A-weighted equivalent sound level, with a 10 decibel penalty appliec to nighttime levels.
L_d	Daytime equivalent A-weighted sound level between the hours of 0700 and 2200.
L_n	Nighttime equivalent A-weighted sound level between the hours of 2200 and 0700.
L_{max}	Maximum A-weighted sound level for a given time interval or event.
NIPTS	Noise-Induced Permanent Threshold Shift.
NITTS	Noise-Induced Temporary Threshold Shift.
OSHA	Occupational Safety and Health Act.
SENEL	Single Event Noise Equivalent Level.

FOREWARD

This Technical Report is the second of two volumes which together constitute the Regional Noise Element for San Luis Obispo County and the incorporated Cities within the County. The first volume, the Policy Report, will be submitted with this report to the County Board of Supervisors, and to each of the City Councils for adoption as one of the state-mandated Elements of local government General Plans. It is intended that once adopted the Noise Element will be updated on a regular basis.

The purpose of this volume of the Noise Element is to provide the necessary technical back-up for the recommendations contained in the Policy Report. The technical nature of some of the information contained in this section necessitates a scientific discussion. However, because of the diverse audience of the Noise Element, the approach has been to minimize the use of detailed mathematical presentations and scientific terminology. Rather, this Report relies for the most part on qualitative descriptions of methodology and noise exposure.

Those wishing a more detailed discussion of noise evaluation techniques are referred to the works listed in the References Section.

I. INTRODUCTION TO NOISE

A. Sound Mechanics

Fundamental to any discussion of environmental noise is an understanding of sound phenomena. Such an understanding is interdisciplinary in that the generation of sound waves is within the traditional domain of physics while the perception of sound is primarily a concern of physiology and psychology. In this section, the emphasis is on the source of sound waves. The next section deals with the reception of sound, and is followed by a discussion of sounds that are defined as noise in the Element.

Sound can be defined as a mechanical form of radiant energy which is transmitted by longitudnal pressure waves in air or another medium. To illustrate this definition, consider a tuning fork in vibration after being struck. As a tong of the fork moves in one direction, it compresses the air particles in its path producing an area of condensation. As the tong reverses direction, the air particles left in its wake spread out resulting in an area of rarefaction. This movement of air particles is a form of wave motion in which the displacements are along the direction of the wave motion and is termed longitudinal wave motion. This is in contrast to transverse waves, such as those in a vibrating string, in which the displacements are perpendicular to direction of wave motion.

Sound waves emitted by a source have two major dimensions: frequency (or pitch) and amplitude (or intensity). Frequency is measured by the number of sound waves passing a point in one second. This measure is termed "cycles per second" or "Hertz" (abbreviated Hz). In general, humans can hear sounds with frequencies from about 16 to 20,000 Hz, although those limits may be decreased or increased somewhat depending on the individual and the intensity of the sound. Sound waves below 16 Hz are in the realm of infrasonics, and cannot be heard. Ultrasonics refers to sound waves above 20,000 Hz which generally cannot be detected by the human ear either.

Amplitude is a measure of the height or depth of sound waves above and below a median line on a diagram of a sound wave (Figure 1). It is the intensity or magnitude of the sound, and is measured in decibels (abbreviated dB). The decibel system is a relative logarithmic scale of sound pressure which is based on human hearing. The scale has a number of important features. Its basic reference point is the weakest sound which a person with very good hearing can detect in a quiet place. This quantity of sound is assigned the value 0 dB. Since the range of sound pressure which the ear can detect is so great, it is necessary to mathematically compress that range on a logarithmic scale of 0 to about 180. The most important aspect of this scale is that it does not progress arithmetically or linearly. That is, while a 10dB sound is ten times as intense as a 0dB sound, 20dB is 100 times as intense as 0dB (rather than 20 times), and 30dB is 1000 times as intense as 0dB (rather than 30 times).

Another important feature of the decibel scale is that sound levels are not directly combined when they are added. For example, if one truck emits 65dB while idling, parking another truck producing 65dB next to it does not generate a total noise level of 130dB. Rather, the total noise level would be 68dB. The basis of this is the logarithmic nature of the decibel scale, and it is an important feature to remember when considering an area exposed to more than one source of noise. A convenient graphic method for combining decibels is provided in Figure 2.

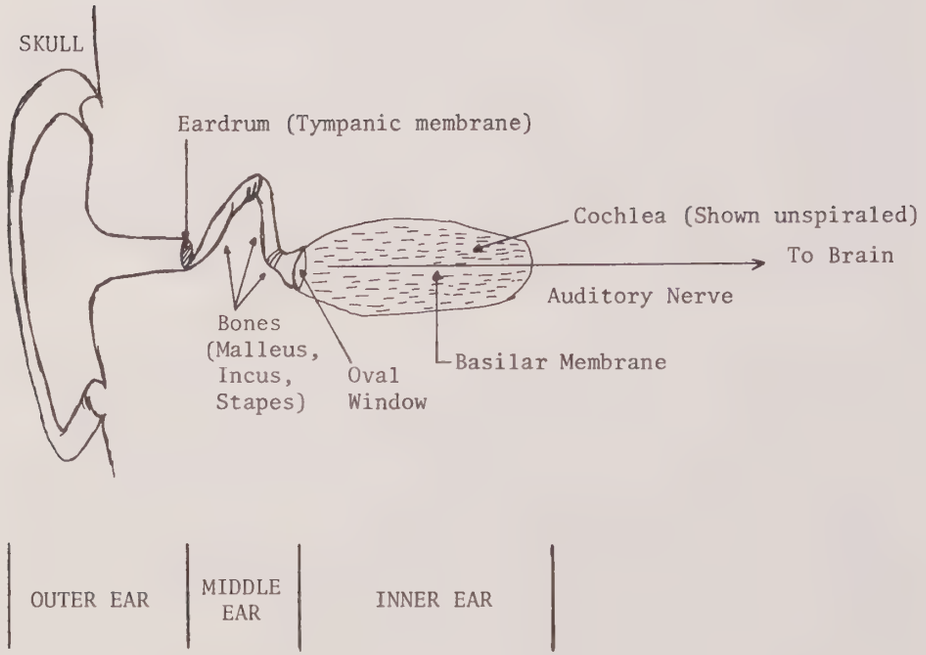


Figure 3. Simple functional diagram of the human ear. (After Kryter, 1970).

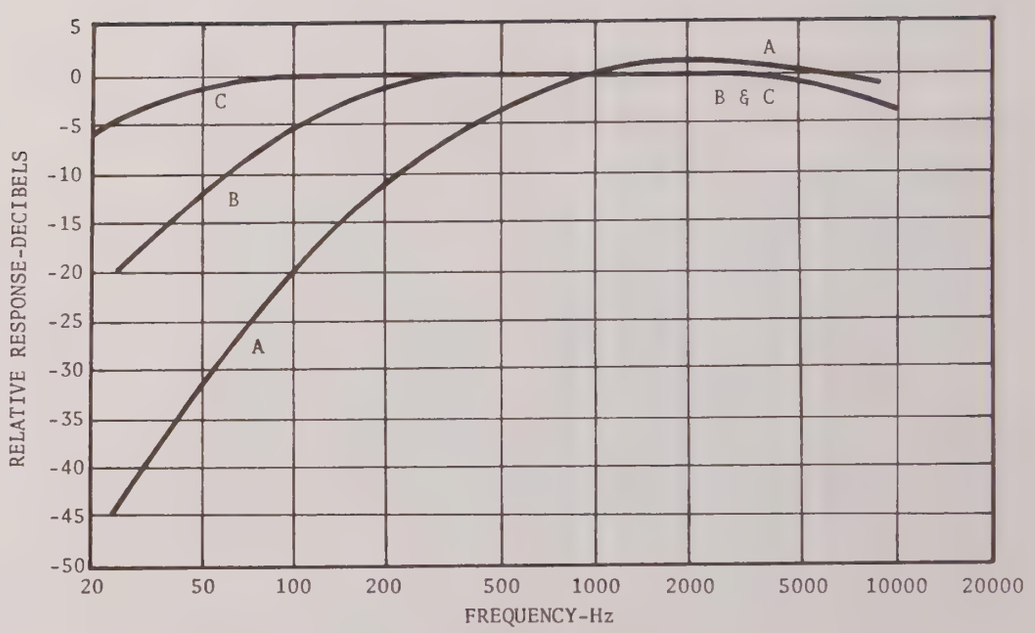


Figure 4. Frequency-response characteristics in the American National Standard Specification for A, B, and C scales in sound level meters. (Source: Peterson, 1972)

To give a better idea of the everyday meaning of some of the above concepts, Table 1 provides a number of examples of sound sources, their approximate decibel output, their relative energy content, and the human response to those sounds.

C. Noise

1. General

At what point does sound become noise? The answer to this question is difficult primarily because of the subjective nature of noise. The American National Standards Institute (ANSI) defines noise as (1) any erratic, intermittent, or statistically random oscillation, or (2) any unwanted sound. It is the definition of noise as unwanted sound that causes difficulty in specifying what is noise and what is not. A common example of the difficulty is music. What may be rock and roll music to some is noise to others. Resolution of this problem at the community level requires a large measure of public participation in defining "acceptable sound."

2. Noise Element

The sources of noise may be thought of as either indoor or outdoor sources. Indoor noise includes all of those devices and machines in the homes, offices, and factories that can create sounds loud enough to damage hearing, interfere with speech communication, and arouse a person from sleep. The concern of this Element, however, is outdoor noise. While both indoor and outdoor noise sources are regulated at the Federal level by the EPA and the Occupational Health and Safety Administration, control of outdoor noise is also a function of local government.

Outdoor noise can be considered in five categories: transportation, construction work, industrial operations, the individual human being (shouting, playing radio too loudly), and miscellaneous noises such as air conditioning units attached to windows or the banging of garbage cans and lids. Of these different categories, noise generated by transportation is the most serious. Transportation accounts for the most continuous, and, in many areas, the loudest noise in urban centers. The emphasis of this Element is on evaluating and planning for transportation noise with a secondary emphasis on stationary noise sources.

Transportation noise sources are considered in this report in three catagories: air, road, and rail traffic noise. It should be noted that noise produced by aircraft in flight is regulated by the federal government and that the legal concern of the Noise Element is only with noise-producing ground operations at airports. An evaluation of noise produced by aircraft in flight is included in this Element, however, in accord with the study contract and to provide necessary land use guidelines.

Stationary source noise is defined in this Element as encompassing all non-transportation sources which do not move and which emit noise on a regular basis. This definition is general and permits inclusion of a wide variety of sources. The definition is somewhat subjective, and the judgement of City and County administrative staff played an important role in locating potential stationary sources. Stationary sources were defined to exclude construction noise or noise made by individual persons.

3. Road Traffic Noise

Within San Luis Obispo County and the Cities in the County, road traffic is the most significant source of

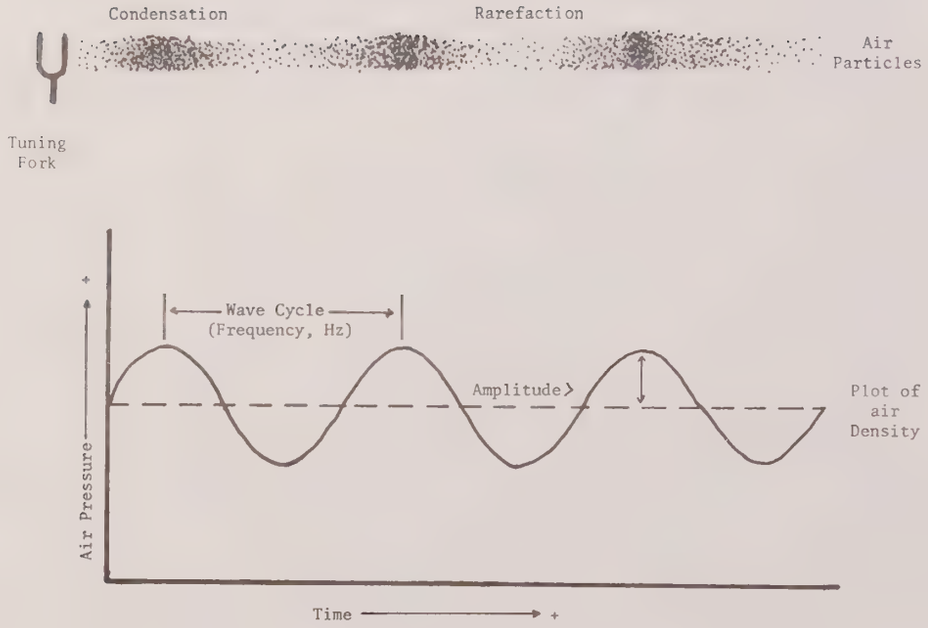


Figure 1. Diagram of Simple Sound Waves

Example: Add 50 and 56 dB. Since the difference between the two levels is 6, enter the at 6 on the horizontal axis. Read up to the curve and read left to 1. Add 1 dB to the higher level, 56, to yield the answer, 57dB.

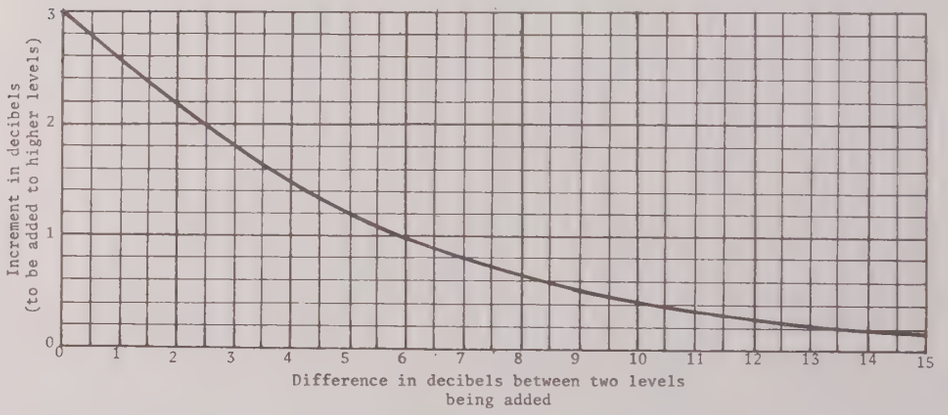


Figure 2. Chart for combining sound levels by "decibel addition".

B. Hearing

"If a tree falls in the woods and no one hears it, is there a sound?" This is an old question, and it serves to emphasize the three major facets of sound: generation, transmission, and perception. The following gives a brief description of the perception of sound, or what happens when someone hears the tree fall.

The ability to hear involves a highly complex process and mechanism. The diagram in Figure 3 is a simplified picture of the ear which illustrates its three major parts: the outer, middle and inner ear. The outer ear may be thought of as an air-filled funnel ending in a membrane, the eardrum. Sound waves travel down the funnel and impinge on the eardrum causing it to vibrate. This vibration mechanically transmits the sound wave to the middle ear which consists of a set of three connected bones. These small bones act as levers to amplify the vibrations on the ear drum, and to distinguish sound waves from the eardrum from those coming through other head tissues and bones. This part of the ear ends in a sound membrane called the oval window which separates the air-filled middle ear from the liquid-filled inner ear or cochlea. The window transmits the mechanical vibrations into liquid waves which travel through the spiral, parallel tubes of the cochlea. A basilar membrane separates two of these tubes; and, as it is distorted by the liquid waves, hair-like cells (cilia) are bent and trigger nerve cell endings by mechanical, chemical and electrical processes. These signals are transmitted to the brain through the auditory nerve.

It is interesting to note that the ear is sensitive to a wide range of acoustic stimuli, but has not evolved involuntary response mechanisms to protect it from very loud noises without temporary or permanent loss of hearing acuity. This contrasts with the eye, which has evolved the dilation mechanism to protect it from overstimulation by light. It is thought that an analogous mechanism to dilation has not developed in the ear because the environmental stimulus, i.e., frequent exposure to loud noise, has not been present. Whether existing levels of noise in large cities is sufficient to initiate natural selection processes is difficult to say, but in any event such adaptation in man would take a long time. The human ear, then, is not well adapted to high levels of noise. This highlights the need to control loud noise before it reaches the ear.

There are a number of important aspects to the hearing process that enter into the evaluation of noise exposure in this Element. One is that the ear does not perceive all frequencies of sound equally. Generally, people are more sensitive to sounds in the higher frequencies than lower frequencies. This means that it takes a greater magnitude low frequency sound to be perceived as equal in loudness to a high frequency sound. This fact is accommodated in noise measurement by the use of an electronic filter in sound level meters that enables a meter to approximate the response of the human ear. Such measures are made by using the A scale of a meter, and are denoted by the letter A in the abbreviation dBA. Other measurement scales are the B and C scales which discriminate less against the lower frequencies, and therefore show somewhat higher decibel readings than the A scale (Figure 4).

Another characteristic of human perception of sound is that it takes much more than twice a reference sound energy level to perceive a doubling in loudness. The average person can detect a difference in sound level at 2dB, but laboratory hearing tests indicate that it takes about a 10 decibel increase for most people to perceive a doubling of loudness. Field experimentation with aircraft noise indicate that the doubling of loudness can be perceived over a wide range, but the 10dB increase per doubling of loudness is an accepted rule of thumb.

Table 1

Sound levels and human response

Relative Sound Energy	Noise Level, dBA	Example	Response	Relative Loudness (Approximate)
1 quadrillion	150	Carrier Deck Jet Operation		32,768
100 trillion	140		Initial Pain Threshold	16,384
10 trillion	130			8,192
			Initial Discomfort Threshold	
1 trillion	120	Jet Takeoff (200 feet) Auto Horn (3 feet)	Maximum Vocal Effort	4,096
100 billion	110	Riveting Machine Jet Takeoff (2000 feet)		2,048
10 billion	100	Garbage Truck		1,024
1 billion	90	Heavy Truck (50 feet)	Very Annoying Hearing Damage (8 hours)	512
100 million	80	Alarm Clock	Annoying	256
10 million	70	Freeway Traffic (50 feet)	Telephone Use Difficult Intrusive	128
1 million	60	Air Conditioning Unit (20 feet)		64
100,000	50	Light Auto Traffic (100 feet)		32
10,000	40	Bedroom Library	Quiet	16
1,000	30	Soft Whisper (15 feet)	Very Quiet	8
100	20	Broadcasting Studio		4
10	10		Just Audible	2
1	0		Threshold of Hearing	1

noise in terms of continuity and the size of the impacted-area. This results simply from the fact that there are greater volumes of road traffic than air or rail traffic, and from the fact that roads exist in areas where there is no airport, rail line or major stationary noise source.

Road traffic noise is generally dominated by emissions from automobiles and heavy diesel trucks. There are five other categories of vehicular noise sources: motorcycles, sport cars, light trucks, large gasoline-engine trucks, and buses. Generally, motorcycles and sport cars are noisier than automobiles because of higher engine speeds and less adequate muffling. Light trucks emit noise levels that are similar to automobiles, while the larger gasoline-fueled trucks are noisier than cars but quieter than diesel-fueled trucks of equal size. Buses are much noisier than automobiles on city streets, but are quieter than diesel trucks on the highway because they are usually better muffled and maintained. As a group, these five types of vehicles normally comprise only a small percentage of the total daily traffic flow. Since their noise emissions are within the range defined by auto and truck emissions, their noise is generally assumed to be contained within the mix generated by cars and trucks.

The principal components of both automobile and truck noise are three: the engine, exhaust and tires. Fans operating as part of the cooling system are a major contribution to engine noise; hot gases escaping out of the exhaust pipe creates noise in that area of the vehicle; and the escape of air from between tire treads and the road surface is the source of tire noise. Four major factors control the noise level of vehicles: speed, acceleration, road grade and road surface. Generally, vehicular noise levels increase directly with increases in speed, acceleration, road grade and with rougher road surfaces. Figures 5 and 6 show the generalized noise spectra of an auto and a truck operating on level, average road surfaces at highway speeds.

4. Rail Traffic Noise

There is only one active rail line in San Luis Obispo County--the Southern Pacific Transportation Company's line which runs near U. S. 101. The line passes through the City of Paso Robles, Atascadero, the City of San Luis Obispo, the City of Pismo Beach, Grover City and Oceano. At one time, the railroad was the principal transportation mode in the County (and throughout the State), but with the age of the internal combustion engine, railroad passenger service has declined almost to extinction. Freight traffic is now the railroad's principal income producer, but even freight operations must compete with trucking and air cargo operations. Southern Pacific's line in San Luis Obispo County is little used, then, except for two Amtrak passenger trains and an average of eight freight trains per day.

Noise produced by rail traffic in the County consists of events which are widely separated in time, but which are intense. Unlike road traffic, train noise is not considered as continuous. When a train passes through, however, it produces a very intense noise, often exceeding 100dB (at 100 feet from the track centerline). The two major components of rail traffic noise are locomotive noise and passenger or freight car noise.

The locomotive produces the most intense noise which is generally thought to be a function of speed and track bed gradient. The relationship between speed and noise output is less well established, however, than the relationship between grade and noise output. Locomotives

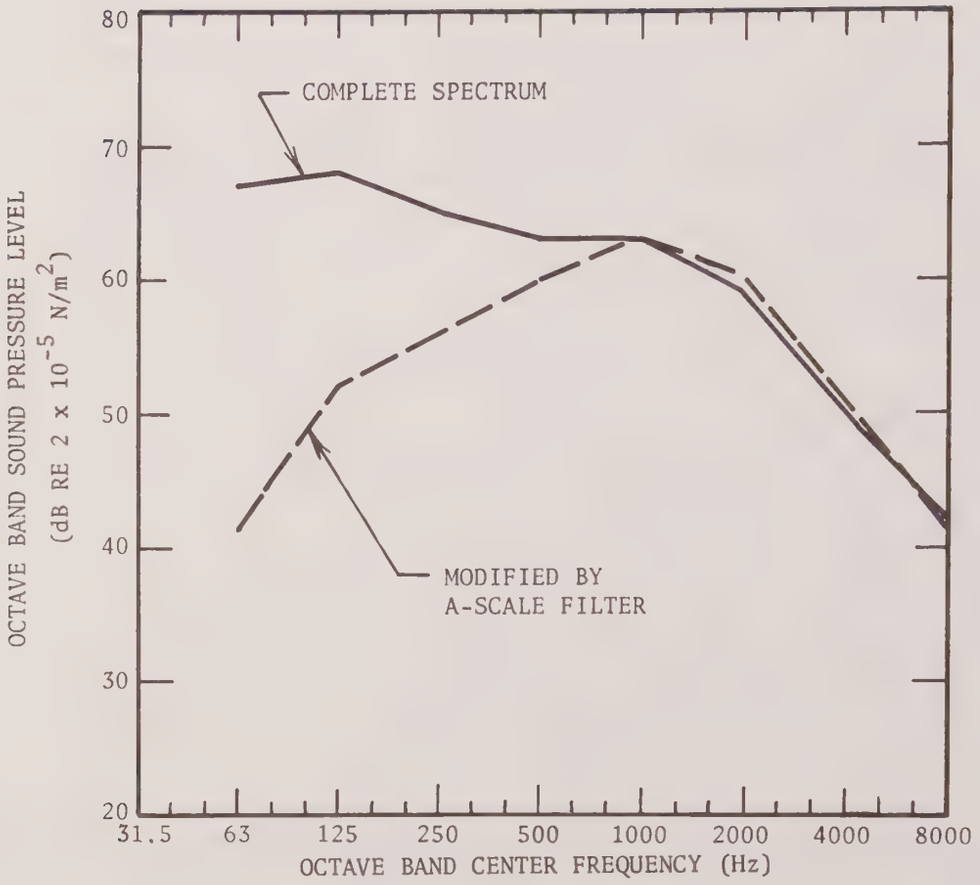


Figure 5. Generalized spectrum of typical passenger automobile at 50 mph speed and at 50 ft. distance. (Source: Bolt, Beranek, and Newman, Inc., 1973)

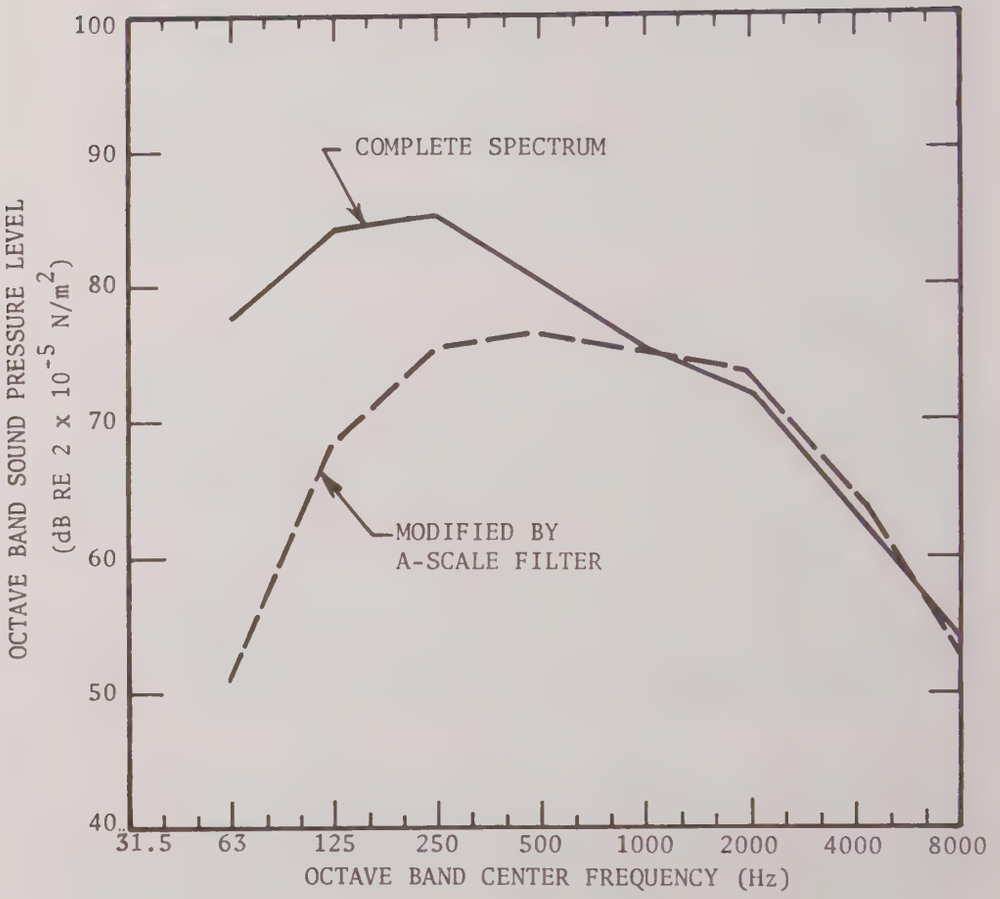


Figure 6. Generalized spectrum of typical diesel truck at 50 ft. distance on level roadway at highway cruising speeds. (Source: Bolt, Beranek, and Newman, Inc., 1973)

pulling upgrade generate significantly more noise than those operating under level or downgrade conditions.

In contrast, car noise is dependent upon velocity and increases directly with increases in speed. The wheel-track interaction is also a primary factor in noise output. Jointed track, frogs and grade crossings, and tight radius curves all act to increase the noise output of rail cars. Figure 7 shows an idealized noise history for a train-pass-by illustrating the locomotive and car components of train noise.

5. Air Traffic Noise

Aircraft noise exposures for the three publicly-owned and used airports in San Luis Obispo County were calculated as part of the work program for this Noise Element. The three are the San Luis Obispo County Airport, Oceano County Airport and Paso Robles Municipal Airport. The San Luis Obispo airport has the largest number of annual operations (68,000) followed closely by the Paso Robles Airport (64,800). The Oceano airport has somewhat less than one-half the annual operations of Paso Robles airport (26,000).

The type of noise generated by air traffic is directly related to the type of propulsion systems used in the aircraft. Both San Luis Obispo and Paso Robles Airports are classified as air carrier airports, and are served by Swift Aire Lines. Swift Aire presently uses a De Havilland "Heron" four-engine, piston-powered propellor aircraft. Other aircraft which use the three public airports are almost exclusively twin or single-engine piston-powered propellor aircraft.

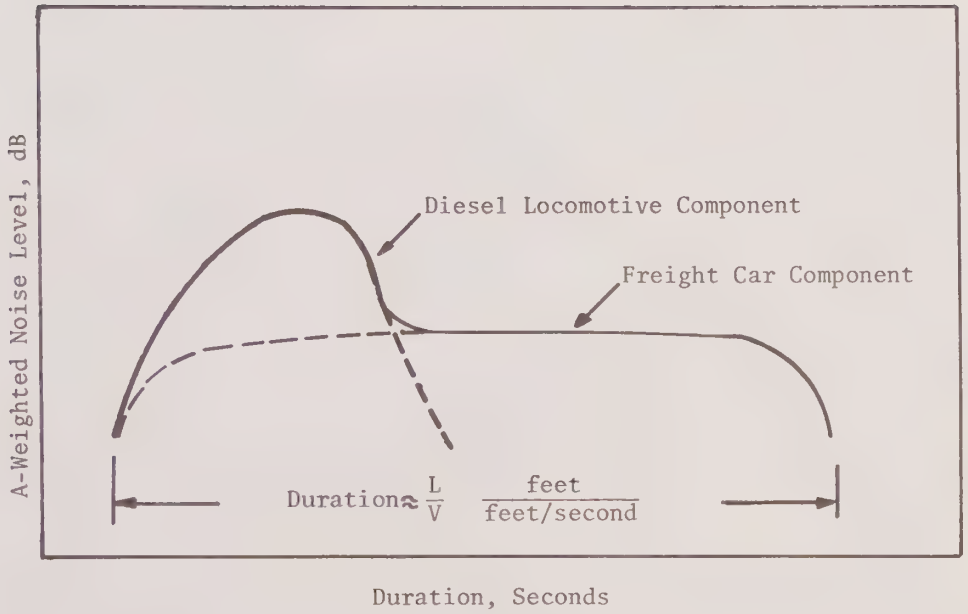


Figure 7. Idealized time history of train passby illustrating locomotive and freight car components. (Source: Wyle Laboratories, 1973)

A small private jet or helicopter may use one of the airports occasionally, but these events are so infrequent that they are insignificant in terms of the total noise environment of the airport vicinity.

Noise emissions from these general aviation and air carrier aircraft are produced primarily by engine exhaust and the interaction between the rotating propellor and the air. In contrast to the buzzing noise of propellor aircraft, jets produce noise by high velocity exhaust and compressor machinery. Jet exhaust produces the roar heard on take-off, while compressor blades are responsible for the high pitched whine dominant in landings.

Light aircraft noise is primarily a function of the throttle setting. Thus, aircraft under full power on take off make a great deal more noise than aircraft under low power on the landing approach. The tip of the rotating propellor is constantly breaking the sound barrier, and the greater this "bite" of the propellor, the higher is the noise level. The amount of bite is related to the rate of climb which is greatest on take off when the plane is pulling its greatest load. There are a number of combinations of propellor pitch, flap settings, air speeds and other parameters which can be adjusted to achieve a rate of climb. Therefore, the same aircraft can be much nosier in the same flight pattern depending on the pilot's selection of take-off parameters. Thus, "low noise" modes can be achieved with light aircraft under certain operating conditions. These operational characteristics are generally controlled by gross weight of the aircraft and ambient weather conditions. As a result, propellor aircraft exhibit a wide range of noise levels.

6. Stationary Source Noise

It is difficult to provide an exact definition of what constitutes a stationary noise source. The general definition used in this Element has three criteria for stationary sources: (1) it is located at a fixed place, (2) it emits noise on a regular basis and (3) it emits noise outdoors. Stationary noise sources are not associated with transportation noise sources. Some examples include agricultural processing mills, concrete batch plants, some power plants, engine run-up areas and various manufacturing processes. Typical sound fields are created at these sources by air compressors, conveyor belts, exhaust fans, engine exhaust and vibration and impact machinery.

A list of potential stationary sources was compiled by County and City planning staff and these sources were investigated in-the-field by government and Envicom staff. The original list was compiled on the basis of use permit and zoning records, complaints filed with the Ordinance Enforcement Section of the County Planning Department, personal staff knowledge, and in-the-field discovery.

As a result of the field investigation, the list of identified stationary sources was reduced greatly from the list of potential sources. Of a list of more than 140 potential sources, only 10 were found to be creating significant noise levels.

There are a number of reasons for the scaled-down number of stationary sources. First, and most importantly, the great majority of potential sources were found to generate noise infrequently and at levels below that of nearby road traffic. Secondly, these sources were located in industrial or commercial areas removed from noise sensitive land uses, or were completely isolated in rural areas of the County, away from land uses which might be affected.

As a result of this survey, it is concluded that stationary noise sources are the least significant source of noise in San Luis Obispo County. The sources which can be considered problems are small in number and are located in only a few jurisdictions.

II. METHODOLOGY

A. Philosophy of Analysis

When evaluating noise exposure, it is necessary to account for a number of diverse parameters. These include not only sound wave amplitudes and frequencies, but also the time characteristics of the noise, reverberation and attenuation by structures and other barriers, the hearing ability of individuals exposed, and their activity during exposure. Such a description entails the use of several numerical indicators and would be specific to a particular site and situation. However, when evaluating noise exposure on a regional and community basis, such a complete description would be impractical. It is necessary, then, to choose a less detailed but reliable descriptive scheme which results in a more general indicator of noise exposure and potential noise problems. This is the approach taken in this Regional Noise Element.

The rating scheme used in this Element to describe transportation noise is the Day-Night Noise Level which results in a generalized single-number indicator of noise exposure. While the establishment of a completely valid single-number noise exposure index has been the goal of psychoacoustic experts for many years, no indicator has proven to be a fully adequate substitute for more complex descriptions. With that qualification in mind, it can be said that the single-number indices are useful tools in defining noise exposure for general planning purposes.

One other qualification regarding the noise exposures described in this report should also be noted. The noise levels were defined by use of mathematical models which rely heavily on the validity of the input data. In a number of instances, these data were incomplete or not available, and it was necessary to make reasonable estimates. In developing these estimates, a conservative approach was taken at each stage of data analysis. The end result of this process is that the noise exposures computed in this analysis may be somewhat high and could be considered to contain a "margin of safety." The intent of this approach is to ensure that any error introduced into the process is on the side of public benefit.

B. Measurement Scheme: Day-Night Noise Level

1. Ldn

In recent years, there has been a proliferation of noise rating schemes or techniques, and different agencies of the Federal and State governments have adopted different techniques. The result has been a general confusion by both government administrators and the public. A resolution to this problem has yet to be found in a uniformly-accepted single-number index of noise exposure that can be applied to all types of noise sources and that accurately reflects human response to sound.

To date, the most promising noise exposure index to be developed is the Day-Night Noise Level (abbreviated Ldn).

This index is based on two premises regarding human response to sound. The first is that humans will respond to a steady noise over a given period of time in the same way that they will respond to a time-varying noise with an equivalent amount of sound energy as the steady noise. The second premise is that humans are generally more sensitive to noise during the night than during the day.

The dominant characteristic of transportation noise is that it is not steady. There are constant fluctuations which may or may not be widely separated in time. At any given moment near a freeway or rail line, it may quiet, but when traffic volumes or speeds increase that quiet is quickly displaced by high noise levels. Therefore, it is

not appropriate to measure noise at any given moment, and call that the noise level of the source. A statistical approach is required to account for the time-varying nature of the sound. Such an approach, however, would yield a large number of statistics to show the day, night, weekday, weekend, fair and foul weather differences in noise levels. Such a large number of parameters make baseline noise level mapping and noise control enforcement extremely difficult, if not impossible to accomplish on a community-wide basis.

The problem of time-fluctuating noise levels is further complicated by the fact that people are exposed to different sources of noise as they move from place to place in the community. For example, a typical factory worker spends time in a relatively quiet residential setting during the night, drives to work in high noise traffic, works around loud machinery all day, except for a quieter period at lunch, and then returns home. This pattern of exposure to different noise levels increases the number of descriptive parameters needed to evaluate the total noise "dosage" of people as they move through the day, and complicates the task of setting standards to protect health and welfare.

To avoid a large number of noise indices, it became necessary for acousticians to develop single-number indicators. As the basis of such indicators, it has been shown that humans respond to steady noises in generally the same way as to fluctuating noises with equal energy content. The level of a constant sound which has the same sound energy as does a time-varying sound is termed the Equivalent Sound Level (abbreviated L_{eq}).

The L_{eq} concept was first introduced in Germany in 1965 to evaluate aircraft noise and has since received wide use in many countries. It has been adequately demonstrated that the L_{eq} can be used to describe the noise levels which cause annoyance and lead to permanent hearing loss.

The Day-Night Noise Level is based on the L_{eq} and the premise that noise at night is more annoying than daytime noise. This is primarily a reflection that most people sleep during the night. The L_{dn} uses the A-scale weighted L_{eq} as the basic expression of noise levels, over a 24-hour period, but applies a 10dB penalty to the noise which occurs during the night hours (defined as 10:00 p.m. to 7:00 a.m.). This means that the method makes noise levels measured at night 10dB higher than they actually are. The summary definition of the L_{dn} is: The A-weighted average sound level in decibels during a 24-hour period with a 10dB weighting applied to nighttime sound levels.

The considerations discussed above form the basis of the rationale for selecting the L_{dn} as the primary noise evaluation scheme for the Noise Element. In summary, the L_{dn} has the following desirable characteristics:

1. The L_{dn} utilizes A-scale measurements of noise corrected for time-variance and nightime exposure, and, therefore, is a reliable single-number index of human response to noise.

2. The measure can be applied to any source of environmental noise, thereby providing a common scale to compare (and add) noise exposure from different sources.

3. The measure can be easily calculated from sound level meter recordings.

4. The measure can be used in predictive methodologies to estimate future noise levels.

2. CNEL

The L_{dn} represents an evolution of a noise measurement scheme called the Community Noise Equivalent Level (CNEL). The CNEL is virtually identical to the L_{dn}, but for one parameter. Rather than dividing the 24-hour day into two parts, the CNEL scheme adds a third period, the evening, which is defined as 7:00 p.m. to 10:00 p.m. Noise events during this evening period are assigned an additional 3dB weighting.

CNEL and L_{dn} noise levels usually agree within plus or minus 1dB for the same noise. The evening noise weighting has not been shown to yield a better indicator of human response to sound, and is considered an unnecessary complexity in the scheme. Therefore, it was dropped when the L_{dn} was developed.

The CNEL scheme was used in this analysis, however, to compute noise exposures of aircraft in flight. Such exposures are not a mandated part of the Element, but were included in this study to meet the requirements of California Administrative Code, Title 4, Sub-chapter 6, for the public airports in the County. This Code section mandates the use of the CNEL scheme in evaluating noise around airports.

It is important to remember for the purposes of this Noise Element, though, that there is no significant difference between the L_{dn} and CNEL noise levels. They may be compared directly, and added in estimating the total noise exposure of a site.

3. Direct Measurement

Because of the wide variety of operational time patterns of stationary noise sources, it was not feasible to apply the L_{dn} scheme in evaluating their noise emissions. Nor was such an analysis deemed necessary since the purpose of the stationary source survey was primarily to identify potential noise problems, and not to provide an in-depth quantitative analysis. The method used to evaluate these sources was direct measurement. Measurements were made with a General Radio Type 1565-B Sound Level Meter and a Pulsar Instruments Model 40 Sound Level Meter. Sound levels from these sources are described in terms of statistical noise levels, termed L_{10} and L_{50} sound levels. The L_{10} level is that level exceeded 10 percent of the measurement time period, and the L_{50} level is the level exceeded 50 percent of the time. For example, the notation L_{10} = 68dBA means that for six minutes of each hour, the noise level exceeds 68 decibels as measured on the A-scale of a sound level meter. An L_{50} = 55dBA means that for 30 minutes of each hour, the noise level exceeds 55 decibels as measured on the A-scale of a sound level meter. When the L_{10} and L_{50} levels are identical, or nearly so, it is an indication that the sound level being measured is constant, that is, a sound whose intensity does not fluctuate widely with time.

C. Mathematical Modeling

1. General

Noise environments around roads and railroads were computed according to mathematical models of road and rail traffic noise developed by Wyle Laboratories. Specifically, the models used are published in Development of Ground Transportation Systems Noise Contours for the San Diego Region (Wyle Research Report WCR 73-8; for road traffic), and Assessment of Noise Environments Around Railroad Operations (Wyle Research Reprot WCR 73-5; for rail traffic). These models are based on a large sample of field

noise measurements of road and rail traffic, and predict L_{dn} noise levels as function of specified traffic data.

Air traffic noise levels were computed using the methodology specified in California Administrative Code, Title 4, Sub-chapter 6. A combination of noise level measurements taken by the San Luis Obispo County Engineer's Office and existing aircraft noise emission data were encoded with flight path and power setting data for machine computation of noise exposure.

A modeling approach was taken in developing the noise contours for two reasons: (1) collection of input data for the models was more practical than collection of field measurements under the time and budget constraints of the study, and (2) modeling techniques for L_{dn} noise levels have been shown to be just as reliable as calculations based on field measurements. As a basis for this second reason, it should be remembered that the L_{dn} is not measured directly, but is calculated from measurements. These calculations require making estimates and developing averages that are subject to the same limits of error as mathematical modeling.

The exact expression of L_{dn} levels is found in integral calculus. For applications to road and rail traffic, however, it is possible to approximate the L_{dn} by expressions which avoid computation of the integral, and are accurate to within less than plus or minus 1dB. The basic expression is:

$$L_{dn} = \overline{SENEL} + 10 \log N - 49.4$$

where,

$\overline{SENEL}$ = Average Single Event Noise Exposure Level

N = Number of road or rail operations

49.4 = a normalization factor equal to 10 log (3600 x 24).

and where,

$$SENEL = L_{max} + 10\log_{10} t_{ea}, \text{ dB}$$

with,

L_{max} = maximum noise level as observed on the A scale of a standard sound level meter.

t_{ea} = effective time duration of the noise level in seconds. It is about equal to ½ of the "10dB down duration" or the duration for which the noise level is within 10dB of L_{max}.

and,

$$N = N_D + 10N_N$$

with,

N_D = Number of operations between 7:00 a.m. and 10:00 p.m.

N_N = Number of operations between 10:00 p.m. and 7:00 a.m.

The only modification of the above equations in computing the CNEL noise level comes in the definition of N. In CNEL computations,

$$N = N_D + 3N_E + 10\ N_N$$

where,

N_D = Number of operations between 7:00 a.m. and 7:00 p.m.

N_E = Number of operations between 7:00 p.m. and 10:00 p.m.

N_N = Number of operations between 10:00 p.m. and 7:00 a.m.

The value of the modeling procedure is that the SENEL has been defined through sample measurements and correlated to such factors as vehicle speed and acceleration. This kind of information, then, along with the number of operations can be used to predict the L_{dn} and CNEL noise levels. Other factors, such as existing noise barriers, can also be accounted for through modeling in estimating the propagation of noise into the community.

2. Input Data

The importance of the input data in mathematical modeling cannot be understated. The accuracy of the final noise level estimate relies heavily on this information as a description of the "real world". The following lists of information describe the kind of input data used in calculating the noise levels of transportation sources. Specific compilations of these data for jurisdictions included in this study are contained in Appendix B.

(a) Road Traffic Data

1. List of roads selected for evaluation.

2. Road segment identification as defined by the following parameters (no. 3 through 9). When one of these parameters changes, a new road segment is defined.

3. Average Daily Traffic (ADT) broken down into hourly flows for the daytime (7:00 a.m. to 10:00 p.m.) and the nighttime (10:00 p.m. to 7:00 a.m.).

4. Lane configurations: number of lanes and average width of median strip divides, if any.

5. Percentage of diesel truck traffic on the road segment.

6. Representative speeds for road segments as determined by the posted speed limit and observations of variations to that limit.

7. Road grade conditions: mild (0 to 2 percent), moderate (3 to 5 percent), and severe (greater than 6 percent).

8. Lane distribution of road traffic by vehicle class; i.e., if the road has more than two lanes, what percent of total cars (and trucks) are in each lane.

9. Road sideline terrain characteristics; i.e., is the sideline elevated, depressed, or level with the roadbed.

(b) Rail Traffic Data

1. Line segment identification.

2. Representative train speeds.

3. Average train lengths.

4. Grade conditions. Grades are considered in three categories: Level (within $\pm$ 0.75 percent), upgrade (greater than + 0.75 percent) and downgrade (greater than - 0.75 percent).

5. Sideline Characteristics.

6. Identification of track characteristics:

   (1) Mainline welded or jointed track

   (2) Low speed classified jointed track

   (3) Presence of switching frogs or grade crossings

   (4) Tight radius curves
   a. radius less than 600 feet
   b. radius 600 to 900 feet
   c. radius greater than 900 feet

   (5) Presence of bridgework
   a. light steel trestle
   b. heavy steel trestle
   c. concrete structure

7. Number of operations broken down into the number of day and night operations.

(c) Air Traffic Data

1. Numbers of based aircraft by the following categories:

   (a) jet (by make and model)
   (b) twin-engine under 12,500 lbs.
   (c) single-engine with 4 or more seats
   (d) single-engine with 3 or fewer seats
   (e) four engine air carriers
   (f) other (e.g. helicopters, STOL)

2. Percentage use of runways

3. Number of operations (take-offs and landings) broken down into day, evening, and nighttime operations.

4. Flight pattern descriptions.

5. Peak day or peak hour estimates of the number of operations.

The information describing road, rail, and air traffic in each of the jurisdictions was provided by engineering and planning staff, the Southern Pacific Transportation Company, airport management staff, and field investigations by Envicom Corporation. The References section lists the sources of published and unpublished data used in computing noise exposure.

D. Future Noise Projections

1. General

In planning for noise control at the local government level, it is necessary to consider what the future noise environment may be like. For the most part, two factors will control environmental noise levels over the next twenty years. These are (1) the level of use transportation facilities will receive, based on estimates of demand, and (2) advances in noise reduction technology and better application of existing technology. It is safe to assume that noise emissions will be reduced at the source to a certain extent. That reduction may be counterbalanced, however, by an increase in the number of sources, specifically, the volume of traffic. In addition, there are limits to what can be achieved in technological solutions to the noise problem. For example, a major contributor to road traffic noise is tire noise. Reductions in tire noise are limited, at least in existing technology, by safety considerations in tread design.

Because of the limitations of technology and the expected increase in traffic, land use regulation will be a necessary part of noise control over the next 20 years.

Through a combination of noise source control by the Environmental Protection Agency and land use control by local governments, a noise environment compatible with a variety of activities can be achieved.

2. Road Traffic

In forecasting 1995 noise levels from road traffic, it has been assumed that automobiles and trucks will still utilize rubber tires on asphalt and concrete surfaces. This assumption limits the amount of noise reduction which can be expected from technological means alone. Even if engine and exhaust noise could be eliminated, the interaction between tire tread and road surface would continue to emit high noise levels.

The characteristics of automobile noise are expected to remain the same as existing vehicles, but the level of noise is forecast to decrease by about 3 dB over the typical range of operating speeds (Figure 8). This level of noise reduction assumes enforcement of legal constraints and application of currently available technology.

Noise emissions from heavy trucks are also assumed to decrease for the forecast year. This will require application of current "state-of-the-art" technology at the production level. Such technology indicates that maximum noise levels of 70 dBA at 50 feet are attainable. This represents a noise level reduction of 10 to 15dB from some models currently in use (Figure 9). Levels much below 70dB do not seem to be feasible at this time because of economic and safety considerations in tire design.

Overall noise levels from road traffic, then, are assumed to decrease at the source for purposes of this Element. If legal constraints go unenforced, or if adequate noise control technology is not applied, noise levels will, of course, increase. Conclusions from the Regional Transportation Plan indicate road traffic volumes will increase from two to four times in various areas of the County by 1995. This translates into an increase in noise levels from 3 to 5dB over current levels. Since it is always possible that the necessary noise control technology will not be applied in the coming years, it is necessary to review this Element periodically to assess the validity of the noise projections.

3. Rail Traffic

For the general planning purposes of this Noise Element, the noise levels associated with current rail traffic are assumed to describe noise levels for the forecast year. The rationale for this assumption is two-fold. Either the railroad will continue to carry freight and few passengers at current volumes, or the railroad will be restored as a major transportation mode. If the second alternative is realized, it is most likely that major track rights-of-way alignments will be effected, and new, high-speed trans will be produced. Some data describing the expected noise effects of this alternative are available from studies of the BART (Bay Area Rapid Transit) system in the San Francisco area and from Department of Transportation studies on experimental trains. Generally, these studies forecast quieter trains which are capable of higher speeds than existing trains. It is not possible to adequately predict the effects of any of this new technology on San Luis Obispo County. Enough information is not available at this time.

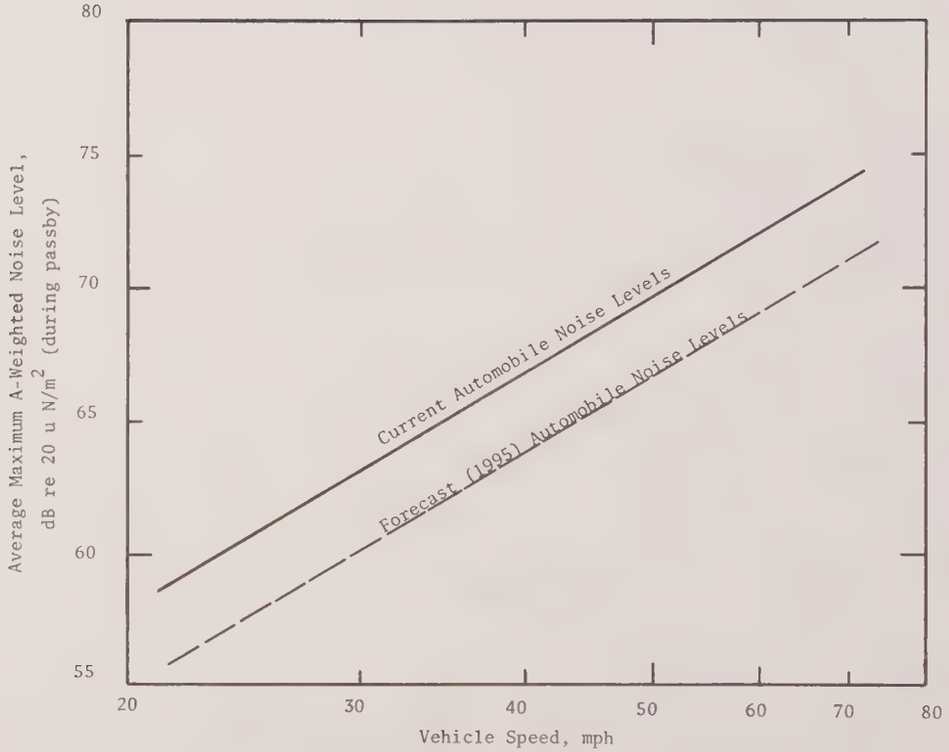


Figure 8. Average maximum passby noise levels of automobiles (at 50 feet) for current and forecast years (Source: Wyle Laboratories, 1973)

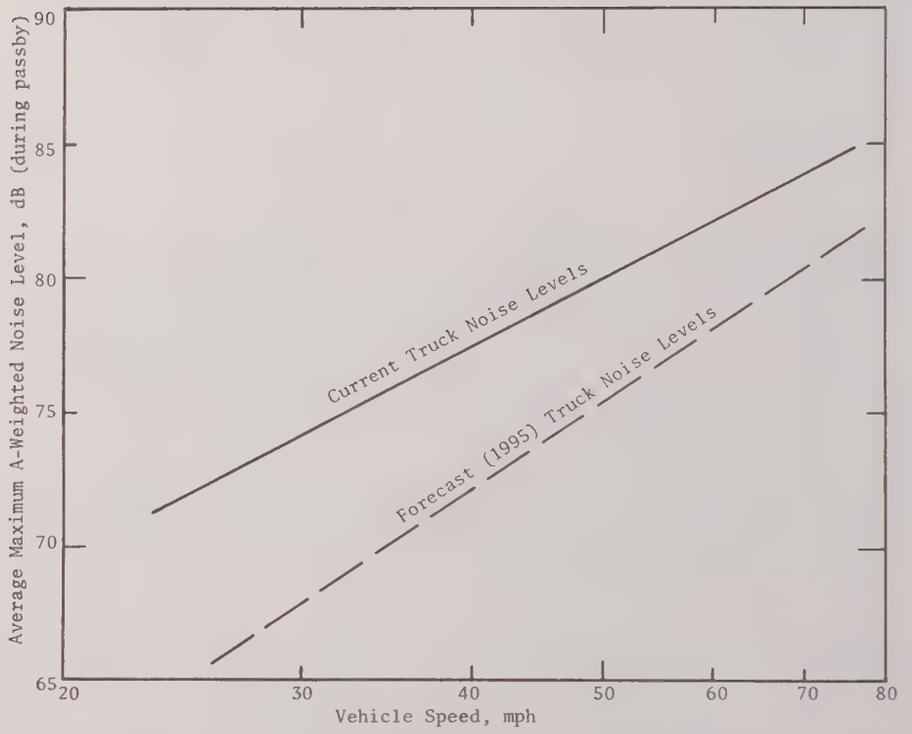


Figure 9. Average maximum passby noise levels of heavy trucks (at 50 feet) for current and forecast years (Source: Wyle Laboratories, 1973).

Continuation of existing levels of rail traffic noise is, therefore, the most realistic projection for at least the intermediate future. As the price of gasoline continues to increase, the relatively energy-efficient train may assume a greater share of the freight traffic in California. Measuring this possible effect and its effect on noise is difficult, and beyond the scope of this Element.

4. Air Traffic

The projected noise exposures for 1995 operations at the three public airports are based on a combined annual operations prediction for 1995 of 298,000 operations. This estimate was obtained from the Regional Transportation Plan. Since no major technological breakthroughs are foreseen which will significantly decrease noise emissions from aircraft, noise levels are expected to increase in the airports' vicinities as a result of increases in traffic. The distribution of operations among the three airports was projected to be the same as for current operations with 44% at San Luis Obispo, 39% at Paso Robles, and 26% at Oceano.

It is important to note that the existing and projected composite noise exposures depicted on the Noise Contours Maps for the airports (as CNEL iso-line contours) are based on daily operations obtained by averaging total annual operations over a 365 day period. This contrasts with the method used in describing road traffic noise which utilizes a peak day to estimate "worst case" noise exposures. The average number of daily operations used in airport noise analysis is, of course, an artificial value which may be approximated only occasionally at the airport in question. The procedure is followed because it is the generally accepted method for describing the composite or average airport community noise exposures and has been encoded in the state law.

The impact of aircraft noise on the surrounding community may be evaluated in more specific terms by considering the actual pattern of daily operations at the airport and the noise produced by specific aircraft types. Operations at San Luis Obispo and Oceano are more variable than at Paso Robles as a result of the frequent overcast from the coastal low cloud cover. Consequently, a clear day at San Luis Obispo may show over 300 operations. This is equivalent to over 100,000 annual operations using the CNEL averaging method. A more careful evaluation of operations at these airports shows many days with a minimal number of flights due to the cloud cover. It is more realistic, then, to assess the range of individual flights and aircraft types which may affect a particular location.

One guideline for single event noise exposures in current use is the 85dBA noise exposure boundary for each of the aircraft types. This describes the distance from the ground flight track to the location where the noise from the aircraft peaks at 85dBA. This concept is useful in that the 85dBA descriptor is a directly measurable phenomenon as opposed to the hypothetical CNEL value. As such, it may be related more directly to other common noise exposures in the environment, e.g., automobiles, trucks, motorcycles, etc. (See Table 1).

There is a substantial variation in the single event noise exposures from the aircraft operating at the three public airports in the County. This may be illustrated by tabulating the approximate limits of the 85dBA noise exposure area for takeoff and landing operations for a few of the aircraft operating at the airports. The values in Table 2 are shown for a single operational condition.

The typical shape of the 85dBA isoline is shown by the curved line in Figure 10. To simplify the tabulation, the values given in Table 2 describe the maximum length and width of the landing and takeoff contours as shown by the arrows in Figure 10. This provides a comparison of the

Table 2
Distances to 85 dBA Noise Exposure Boundary
for selected aircraft for
San Luis Obispo, Paso Robles, and Oceano
Airports

	Operating Conditions		Distance from Ground Flight Track to 85 dBA Noise exposure Limit (ft)			
			Takeoff		Landing	
	Takeoff Gross Wt. Lbs.	Landing Gross Wt. Lbs.	Length	Width	Length	Width
Beech Craft Baron	5000	Max.	7600	480	3250	160
Cessna 150	1600	Max	5820	405	2170	145
Cessna 340	6060	Max	8750	465	3475	150
Dehavilland Heron	12500	Max	9100	490	3700	175
Lear Jet	13000	Max	16840	1620	17830	790
Cessna Citation	10850	Max	7520	515	2710	135
DC 9-10	80000	Max	25400	2720	16850	695

Notes:

1. Noise levels will vary with operating conditions.
2. Length of takeoff contour is from start of takeoff roll (See Figure 10).
3. Length of landing contour is from landing threshold (See Figure 10).

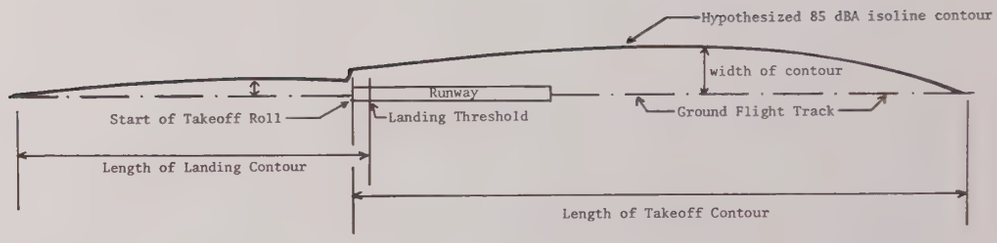


Figure 10. Dimensions of idealized aircraft noise exposure boundaries. (See Table 2 for specific aircraft noise exposures.)

relative noise impact of the different aircraft.

These noise exposure areas are affected by two primary factors: the noise emission from the propulsion system and the performance capabilities of the aircraft. The first factor, the basic noise of the engine(s), will vary with the power schedule during different phases of the flight. The performance characteristics of the aircraft will be influenced by several considerations including design, gross weight and weather conditions. This will affect the speed and rate of climb and, as a result, the distance from the noise source to a specified location on the ground.

Once these single events have been related to other familiar noise exposures, it is necessary to determine the number of events which may be reasonably tolerated for any designated land use. As noted previously, an aircraft flyby may be put in the context of other moving noise sources such as motor vehicles. The aircraft noise exposure will occur in much the same way, rising to a maximum level, then decreasing to inaudibility over a short time of the order of 10-30 seconds. Aircraft noise peaking at 85dBA will be directly comparable to the noise from a diesel truck passing at 100-200 foot distance or a motorcycle accelerating past at a distance of 50-100 feet.

These single event noise exposure values constitute a useful supplement to the more familiar composite noise contours in forecasting noise exposures around airports. The composite values serve as a useful general guideline to identify regions where there may be a potential conflict between land use and airport operations. In actual practice, however, there is more often a need to evaluate the land use (existing or proposed) for specific land parcels. The single event noise data are more useful for this prupose. These values may be assessed in terms of noise acceptability criteria relating to human activities, i.e., hearing loss, speech interference, sleep arousal, performance or annoyance. The point here is that land use compatibility should be evaluated using all available noise exposure data and should be conducted on a specific site or problem basis.

5. Stationary Sources

No attempt is made in this Element to provide quantitative forecasts of noise from stationary sources. It is assumed that current noise levels will persist unless the appropriate government agency requires the noise producer to limit his emissions. As the County continues to grow, new industries are likely to locate here bringing with them the possibility of new sources of noise. All new projects in the County should be evaluated on a case-by-case basis for potential noise problems during the project review process. Appropriate mitigation measures should be required for excessive noise emissions from any stationary source.

E. Noise Contouring

Quantitative estimates of existing and future noise exposure in the County and Cities are provided in two forms in this report. Appendix C contains this data in tabular form, and the Noise Contours Maps show the data in graphic form. The noise contours are lines connecting points of equal sound intensity. They form bands 5dBA in width along the roads, railroad, and around the airports. Some attempt was made in this analysis to account for the attenuative effects of the more significant sideline features along the freeway and rail line. These are primarily the areas in which the route is depressed relative to the surrounding topography or is immediately adjacent to a large elevation. The effect of these sideline features is to attenuate the propagation of higher sound levels into the community. This is represented by the contour lines being closer together. Analysis of attenuation and reverberation due to small sideline features, such as buildings, is beyond the scope of this analysis, and would not be appropriate to noise evaluation at a city-wide level for general planning purposes. It should be remembered, then, that the noise contours are general indicators of noise exposure and not precise levels.

The preparation of the noise contour maps involved a certain amount of estimating and smoothing. For example, the contour lines at intersections of roads were rounded away from the intersections indicating an increase in noise levels. Intersections are generally noisier than line sources because traffic volumes increase there. Additionally, many vehicles (e.g. trucks) create more noise under stop-and-go conditions than at steady speeds. The rounding of the contour lines represents this condition, but is not an exact estimate of the magnitude. Precise estimates should be made through site analysis.

Government Code Section 65302(g) requires that the noise contours be continued down to 65 dBA except for regions involving medical or mental health care facilities and outdoor recreation areas. In these latter areas, the contours are to be continued down to 45 dBA. The procedure used in this Element was to carry the contours down to 55 dBA in all areas, and to 45 dBA in the areas specified in the State Code. It should be noted, however, that the accuracy of the 50 dBA and 45 dBA contours is open to considerable question. These are very low noise levels and they occur at such long distances from the sources that it is difficult to attribute them to the transportation source at all. For example, an open field in a low density residential area would measure at about 40 dBA. A bird chirping in that field can increase the sound level to 50 dBA. Other sources, then, can exceed 50 dBA at long distances from a freeway or railroad making it difficult to determine the sound level generated by the freeway or railroad.

III. NOISE ENVIRONMENT

A. Noise-Sensitive Land Uses

The Noise Contours Maps show the location of existing and proposed parks, schools, and hospitals as examples of noise sensitive land uses. The omission of other land uses from the maps is not intended to imply that these are the only noise sensitive uses. Rather, these are the examples required by the Government Code.

All land uses may be considered to be sensitive to noise, but to different levels. Land use sensitivities may be thought of as a continuum with some uses able to tolerate a high level and others unable to tolerate any but the quietest level. The level of tolerable or "acceptable" noise is a function of the subjective desires of the community, and the average exposure times of people in different areas. This latter concept is related to the premise underlying the Sound Equivalent Level. That is, it is acceptable to be exposed to high noise levels for part of the day as long as this exposure is compensated by being in a quiet environment later on. For example, the acceptable noise level for industrial land use is 75 dBA (L_{dn}). A person working in that environment, however, should be compensated by spending a certain amount of time in an interior residential area where the acceptable noise level is 45 dBA (L_{dn}).

The land use noise standards recommended in the Policy Report serve, in effect, to define the sensitivity of each land use. The maximum acceptable noise level for a land use is the level dividing the "Normally Acceptable" and "Normally Unacceptable" noise levels. A summary of these noise level standards is presented in Table 3. These standards may be used in identifying potential noise conflict areas as described in the next section.

B. Noise Conflict Areas

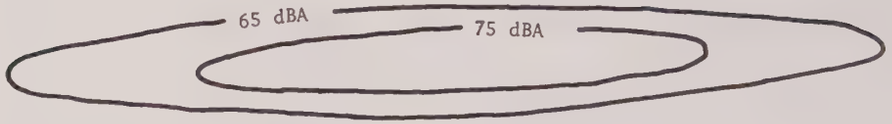
Potential noise conflict areas are shown on the Noise Contours Maps as cross-hatched areas of the noise sensitive uses shown on the map. These conflict areas are those sections of an existing or proposed land use exposed to noise levels which are incompatible with that use of the land. They are termed "potential" noise conflict areas because both the land use and noise exposure representation are generalized. A site analysis might show that the particular area in conflict is not as sensitive as the general land use. For example, the conflict areas of some hospitals occur within 100 or 200 feet of the roadway. It could be that these areas are used for parking rather than hospital wards. It could also be that structures or other noise barriers exist at the site which reduce the noise to acceptable levels. The intent of identifying these noise conflict areas, then, is to point out those places which deserve site analysis in a noise control program.

The actual identification of a noise conflict area is a simple, graphical problem given the noise sensitivities of various land uses and a noise contours map. By overlaying a land use map with a noise contours map, identification of conflicts can be made directly as illustrated in Figure 11. Once these conflict areas have been identified, it is recommended that a site analysis be conducted to determine the precise nature of the noise problem, if any is confirmed to exist.

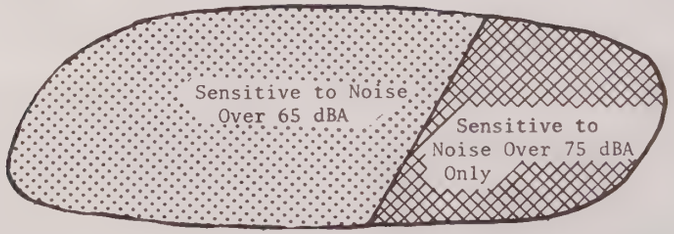
FIGURE 11

NOISE CONFLICT MAPPING

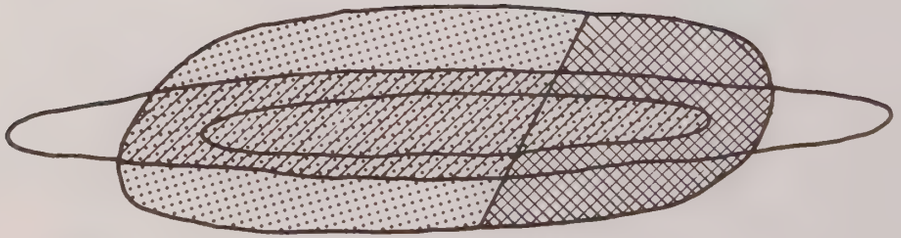
Step 1: Map Noise Contours



Step 2: Map Noise Sensitivity



Step 3: Identify Conflicts



Incompatible Land Use

Table 3. Summary Land Use Compatibility Standards

Land Use Category	Normally Acceptable Exterior Noise Exposure, L_{dn}, dBA [1]
Residential-Single Family, Duplex, Mobile Homes, Multiple Family, Dormitories, etc.	60
Transient Lodging	70
School Classrooms, Libraries, Churches	65
Hospitals, Nursing Homes	65
Auditoriums, Concert Halls, Music Shells	60
Sports Arenas, Outdoor Spectator Sports	65
Playgrounds, Neighborhood Parks	65
Golf Courses, Riding Stables, Water Recreation, Cemeteries	70
Office Buildings, Personal, Business, and Professional	75
Commercial-Retail, Movie Theaters, Restaurants	75
Commercial-Wholesale, Some retail, Industry, Manufacturing, Utilities	80
Manufacturing-Communications (Noise sensitive)	70
Livestock Farming, Animal Breeding	75
Agriculture (except Livestock), Mining, Fishing	95
Public Right-of-Way	85
Extensive Natural Recreation Areas	75

[1] These noise exposure levels represent the upper limit of the range of "normally acceptable" noise levels. Normally acceptable" is defined as being an exposure that is great enough to be of some concern, but common building constructions will make the indoor environment acceptable, even for sleeping quarters. Above these levels, unusual and costly building constructions are necessary to ensure adequate performance of activities

Table 4 contains a list of potential noise conflict areas in the member jurisdictions of the Area Coordinating Council. It should be noted that this relatively short list of potential noise conflict areas does not consider land uses other than parks, schools, and hospitals. Incompatible outdoor noise levels may well impact residential or commercial uses which were not included in this analysis.

Table 4. Potential Noise Conflict Areas

Jurisdiction	Noise Sensitive Area	Local Noise Source
City of San Luis Obispo	French Hospital	Johnson Avenue
		Southern Pacific Railroad
	County Hospital	Johnson Avenue
	Laguna Lake Park Site	Madonna Road
	Sinsheimer Park	Southern Pacific Railroad
	San Luis Obispo Senior and Junior High Schools	Southern Pacific Railroad
City of Paso Robles	Pioneer Park	U S 101
		Southern Pacific Railroad
	Robbins Field Ball Park	Southern Pacific Railroad
City of Morro Bay	Lila H. Keiser Pk.	State Highway 1
	Morro Bay Rest Home	State Highway 1

Table 4 (continued)

Jurisdiction	Noise Sensitive Area	Local Noise Source
City of Pismo Beach	North Beach Campground	State Highway 1
	Pismo Creek Park	U S 101
		Southern Pacific Railroad
City of Arroyo Grande	El Camino Wayside Pk.	U S 101
	Dower Park	U S 101

C. Noise Exposures

Noise exposure is defined as the total acoustical stimulation reaching a person's ear over a specified period of time. How much noise exposure is acceptable for what land uses and times of day are questions that are addressed in the Policy Report. The recommended land use noise compatibility guidelines in the Policy Report are intended to provide some answers. Using these guidelines (summarized in Table 3) as criteria for analysis, Table 5 lists the major noise sources in the various areas of the County. The guiding criteria in judging whether a transportation noise source is a "major" source is whether it emits an L_{dn} of 65dBA or more. The stationary noise sources shown in the table were judged to be major sources on the basis of the field investigations. Noise exposures from these sources are likely to be incompatible with the more sensitive land uses such as parks, schools, hospitals, and residences. These sources, then, may be considered as the potential noise problems in the County and Cities. In most cases, these sources are generating significant noise during the current year and are projected to continue generating high noise

levels in the forecast year, 1995. In other cases, however, the source may not be a major problem now but probably will be by 1995 (e.g. Los Osos Valley Road in South Bay).

Table 5
Major Noise Sources

Area/Jurisdiction	Noise Sources			
	Roads	Railroad	Airports	Stationary Sources
Rural County Areas (Garden Farms, Santa Margita, San Miguel, Wellsona, Templeton, Shandon)	U S 101 State Highways 1, 41, 46, 227, El Camino Road	Southern Pacific	None	·Union Oil Refinery (South County) ·Asphalt Plant (Templeton)
South Bay	Los Osos Valley Road	None	None	None
Cayucos	State Highway 1	None	None	None
Cambria	State Highway 1	None	None	None
Atascadero	U S 101 State Highway 41, El Camino Real	Southern Pacific	None	Cabinet Shops
Oceano	None	Southern Pacific	Oceano County Airport	·Oceano Packing Plant ·American Forest Products ·Oceano Ice Company ·Phelan and Taylor Produce

Table 5
Major Noise Sources (con't)

Area/Jurisdiction	Noise Sources			
	Roads	Railroad	Airports	Stationary Sources
Nipomo	U S 101	None	None	None
City of San Luis Obispo	U S 101 Madonna Road Foothill Blvd. Santa Rosa St. Monterey St. Johnson Ave.	Southern Pacific	San Luis Obispo County Airport	None
City of El Paso de Robles	U S 101, State Highway 46, Spring Street, 24th Street	Southern Pacific	Paso Robles Municipal Airport	Cal Almond Plant
City of Morro Bay	State Highway 1, Morro Bay Blvd.	None	None	P G & E Power Plant
City of Pismo Beach	U S 101, State Highway 1	Southern Pacific	None	None
Grover City	U S 101, State Highway 1, Grand Avenue	Southern Pacific	None	Union Ready Mix Batch Plant
City of Arroyo Grande	U S 101, Grand Avenue Valley Road	Noise	None	None

IV. CONCLUSIONS AND ASSUMPTIONS

The following conclusions and assumptions are a summary of the major technical findings of this analysis of environmental noise in San Luis Obispo County, and are integral to the objectives of the Policy Report.

Conclusions

1. In general, San Luis Obispo County may be considered a relatively quiet environment even within most of its Cities and unincorporated urban areas. In all jurisdictions within the County, 14 potential noise conflict areas were identified from a list of 115 possible problem areas. Of 140 possible stationary noise sources investigated, 10 were identified as major noise sources. Of hundreds of road segments evaluated for traffic noise, segments on five principal roadways were associated with high noise levels. This is not to say that the County is without noise problems. Rather, the major noise sources are few in number and of limited impact.

2. The most significant sources of noise in the County is road traffic, followed by rail and air traffic. Stationary noise sources were not found to be significant sources of noise within the County.

3. Of the roads evaluated for noise exposure, the following were found to be associated with high noise levels: U S 101, State Highways 1, 41, 46, 227, El Camino Real in Atascadero, Spring Street and 24th Street in Paso Robles, Morro Bay Boulevard in Morro Bay, Grand Avenue in Grover City, Grand Avenue and Valley Road in Arroyo Grande, and the following roads in the City of San Luis Obispo: Madonna Road, Foothill Boulevard, Santa Rosa Street, Monterey Street, and Johnson Avenue.

4. Rail traffic on the Southern Pacific line is infrequent, but creates intense noise events such that the total sound energy associated with the railroad is nearly equivalent to that of U S 101. Urban areas impacted by railroad noise include the City of Paso Robles, Atascadero, the City of San Luis Obispo, the City of Pismo Beach, Grover City, and Oceano.

5. The three public airports in the County are sources of local noise. However, with the exception of San Luis Obispo Airport, high noise levels (i.e., 65 dBA CNEL or higher), are restricted to airport property for both the current and forecast years.

6. Potential noise conflict areas have been identified at the following sites: in the City of San Luis Obispo-French Hospital, County Hospital, Laguna Lake Park site, Sinsheimer Park, and the Sna Luis Obispo Senior and Junior High Schools; in the City of Arroyo Grande-El Camino Wayside Park, and Dower Park; in the City of Pismo Beach-North Beach Campground, and Pismo Creek Park; in the City of Paso Robles,-Pioneer Park, and Robbins Field Ball Park; in Morro Bay-Lila H. Keiser Park, and Morro Bay Rest Home. Site acoustic studies will aid in defining the precise nature of the noise problems, should any be confirmed to exist.

Assumptions

1. Future noise levels due to road traffic are expected to be a function of increased traffic volumes and the application of noise control technology. The analysis of this report assumes that noise control technology will be applied, and that this will counteract the expected increase in road traffic in most, but not all, cases. Thus, road traffic noise is forecast to remain the same or decrease somewhat by 1995.

2. The future of the railroad is in a state of flux at this time, making the task of quantitative noise projection impractical. Current noise levels are assumed to persist for at least the intermediate future.

3. No major technological breakthrough is foreseen which will significantly reduce the noise emissions of reciprocating engine aircraft. Noise levels around the three public airports are, therefore, expected to increase in the forecast year due to increases in traffic. However, even these increased noise levels will not significantly affect land outside the airport property except in the case of San Luis Obispo Airport.

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APPENDIX A

GLOSSARY

Acoustics - The science of sound.

Amplitude - The maximum departure of the value of an alternating wave from the average value (Webster). In sound waves, the amplitude is the intensity of the sound.

A-Scale - Electronic network in a sound level meter which has frequency-response characteristics similar to the human ear.

Audible Range (of Frequency) (Audio-Frequency Range) - The frequency range 16 Hz to 20,000 Hz (20 kHz). Note: This is conventionally taken to be the normal frequency range of human hearing. (EPA)

Audiometry - The measurement of hearing. (EPA)

Broad-Band Noise - Noise whose energy is distributed over a broad range of frequency (generally speaking, more than one octave). (EPA)

Condensation (Compression) - An area of dense or compact particles caused by wave motion.

Continuous Noise - On-going noise whose intensity remains at a measurable level (which may vary) without interruption over an indefinite period or a specified period of time. (EPA)

Deafness - One hundred percent impairment of hearing associated with an organic condition. Note: This is defined for medical and cognate purposes as the hearing threshold level for speech or the average hearing threshold level for pure tones of 500, 1,000 and 2,000 Hz in excess of 92dB. (EPA)

Decibel - The decibel is one tenth of a bel. Thus, the decibel is a unit of level when the base of the logarithm is the tenth root of ten, and the quantities concerned are proportional to power.

Note 1: Examples of quantities that qualify are power (any form), sound pressure squared, particle velocity squared, sound intensity, sound-energy density, voltage squared. Thus, the decibel is a unit of sound-pressure-squared level; it is common practice, however, to shorten this to sound pressure level because ordinarily no ambiguity results from so doing.

Note 2: The logarithm to the base the tenth root of 10 is the same as ten times the logarithm to the base 10; e.g., for a number X^2, $\log_{10} 1/10X^2 = 10 \log_{10} X^2 = 20 \log_{10} X$. This last relationship is the one ordinarily used to simplify the language in definitions of sound pressure level, etc. (American National Standard Acoustical Terminology (S1.1 - 1960 (R1971)).

Equivalent Sound Level - The level of a constant sound which, in a given situation and time period, has the same sound energy as does a time-varying sound. Technically, equivalent sound level is the level of the time-weighted, mean square, A-weighted sound pressure. The time interval over which the measurement is taken should always be specified. (EPA)

Environmental Noise - By Sec 3(11) of the Noise Control Act of 1972, the term "environmental noise" means the intensity, duration, and character of sounds from all sources. (EPA)

Frequency - The number of sound waves which pass a given point in one second. Frequency is measured in "cycles per second" (cps) or Hertz (Hz).

Hearing Loss - Impairment of auditory sensitivity; an elevation of a hearing threshold level.

Hearing Threshold Level for an Ear - The amount by which the threshold of hearing for an ear (or the average for a group) exceeds the standard audiometric reference zero (ISO, 1964; ANSI, 1969). Unites: decibels.

Hertz - Unit of frequency equal to one cycle per second.

Impulse Noise - Noise of short duration (typically, less than one second) especially of high intensity, abrupt onset and rapid decay, and often rapidly changing spectral composition. Note: Impulse noise is characteristically associated with such sources as explosions, impacts, the discharge of firearms, the passage of supersonic aircraft (sonic boom) and many industrial processes.

Infrasonic - Having a frequency below the audible range for man (customarily deemed to cut off at 16 Hz).

Noise - 1. Any undesired sound. By extension, noise is any unwanted disturbance within a useful frequency band, such as undesired electric waves in a transmission channel or device.

2. An erratic, intermittant, or statistically random oscillation.

Note 1: If ambiquity exists as to the nature of the noise, a phrase such as "acoustic noise" or "electric noise" should be used.

Note 2: Since the above definitions are not mutually exclusive, it is usually necessary to depend upon context for the distinction. (American National Standard Acoustical Terminology SI.1 - 1960 (R 1971)).

Noise Contour - A line connecting points of equal sound intensity.

Noise Exposure - The cumulative acoustic stimulation reaching the ear of the person over a specified period of time (e.g., a work shift, a day, a working life, or a lifetime). (EPA)

Noise Hazard (Hazardous Noise) - Acoustic stimulation of the ear which is likely to produce noise-induced permanent threshold shift in some of a population. (EPA)

Noise-Induced Permanent Threshold shift (NIPTS) - Permanent threshold shift caused by noise exposure corrected for the effect of aging (presbyacusis). (EPA)

Noise-Induced Temporary Threshold Shift (NITTS) - Temporary threshold shift caused by noise exposure. (EPA)

Octave - 1. The interval between two sounds having a basic frequency ratio of two.

2. The pitch interval between two tones such that one tone may be regarded as duplicating the basic musical import of the other tone at the nearest possible higher pitch.

Note 1: The interval, in octaves, between any two frequencies is the logarithm to the base 2 (or 3.322 times the logarithm to the base 10) of the frequency ratio. Note 2: The frequency ratio corresponding to an octave pitch interval is approximately, but not always exactly, 2:1. (American National Standard Acoustical Terminology SI.1 - 1960 (R 1971)).

Psychoacoustics - A branch of the science of acoustics which deals with hearing, the sensations produced by sounds, and the problems of communication. (Webster)

Sound Level - The quantity in decibels measured by a sound level meter satisfying the requirements of American National Standards Specification for Sound Level Meters S1.4-1971. Sound level is the frequency-weighted sound pressure level obtained with the standardized dynamic characteristic "fast" or "slow" and weighting A, B, or C; unless indicated otherwise, the A-weighting is understood. The unit of any sound level is the decibel, having the unit symbol dB. (EPA)

Sound Exposure Level - The level of sound accumulated over a given time interval or event. Technically, the sound exposure level is the level of the time-integrated mean square A-weighted sound for a stated time interval or event, with a reference time of one second. (EPA)

Sound Pressure Level - In decibels, 20 times the logarithm to the base ten of the ratio of a sound pressure to the reference sound pressure of 20 micropascals (20 micronewtons per square meter). In the absence of any modifier, the level is understood to be that of a mean-square pressure.

Rarefaction - Area of minimum pressure in a medium transverved by compression waves.

Ultrasonic - Having a frequency above the audible range for man (conventionally deemed to cut off at 20,000 Hz.)

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